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CALIFORNIA FISH AND GAME

"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

Volume 29 San Francisco, July, 1943 Number 3

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CALIFORNIA FISH AND GAME is a publication devoted to the conservation of wildlife. It is published quarterly by the California Division of Fish and Game. All material for publication should be sent to Brian Curtis, Editor, Division of Fish and Game, Ferry Building, San Francisco, California.

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Killed in Line of Duty

Byron Sylvester

SALMON AT FRIANT DAM—1942 [1]

By G. H. CLARK

Bureau of Marine Fisheries
California Division of Fish and Game

Early in 1942 the 320-foot Friant Dam, a part of the Central Valleys Project, was completed. This structure formed a complete barrier across the San Joaquin River to upstream migrations of fish, principally salmon. No fish ladder or fish lifts were recommended for this dam, because of the very limited salmon spawning areas above the reservoir high water mark.

Detailed surveys of the San Joaquin River for available salmon spawning beds revealed 417,000 square feet of gravel riffle in 26 miles of channel between the old Lanes Bridge and Kerchoff Powerhouse. The Friant Dam cuts off 36 per cent of this area, but most of this 36 per cent will be submerged when the reservoir is full.

The upper San Joaquin River has had a fair-sized spring run of king salmon for many years. The natural fall run of salmon has been greatly reduced by a sand dam which blocks the main river in the summer and early fall each year between the towns of Dos Palos and Firebaugh. A late fall run of salmon occurs after this sand dam is washed or taken out in late November.

In the spring of 1942, spring-run salmon below Friant Dam were first reported gathering on May 23. Observations were made by the writer on May 26. On this date no salmon were seen, although they were reported by local workers to be below the dam in large numbers. These reports stated that it was the best run of salmon in the San Joaquin in many years. This may have been due to the fact that it was the first time the fish had been concentrated in a small area and could be seen.

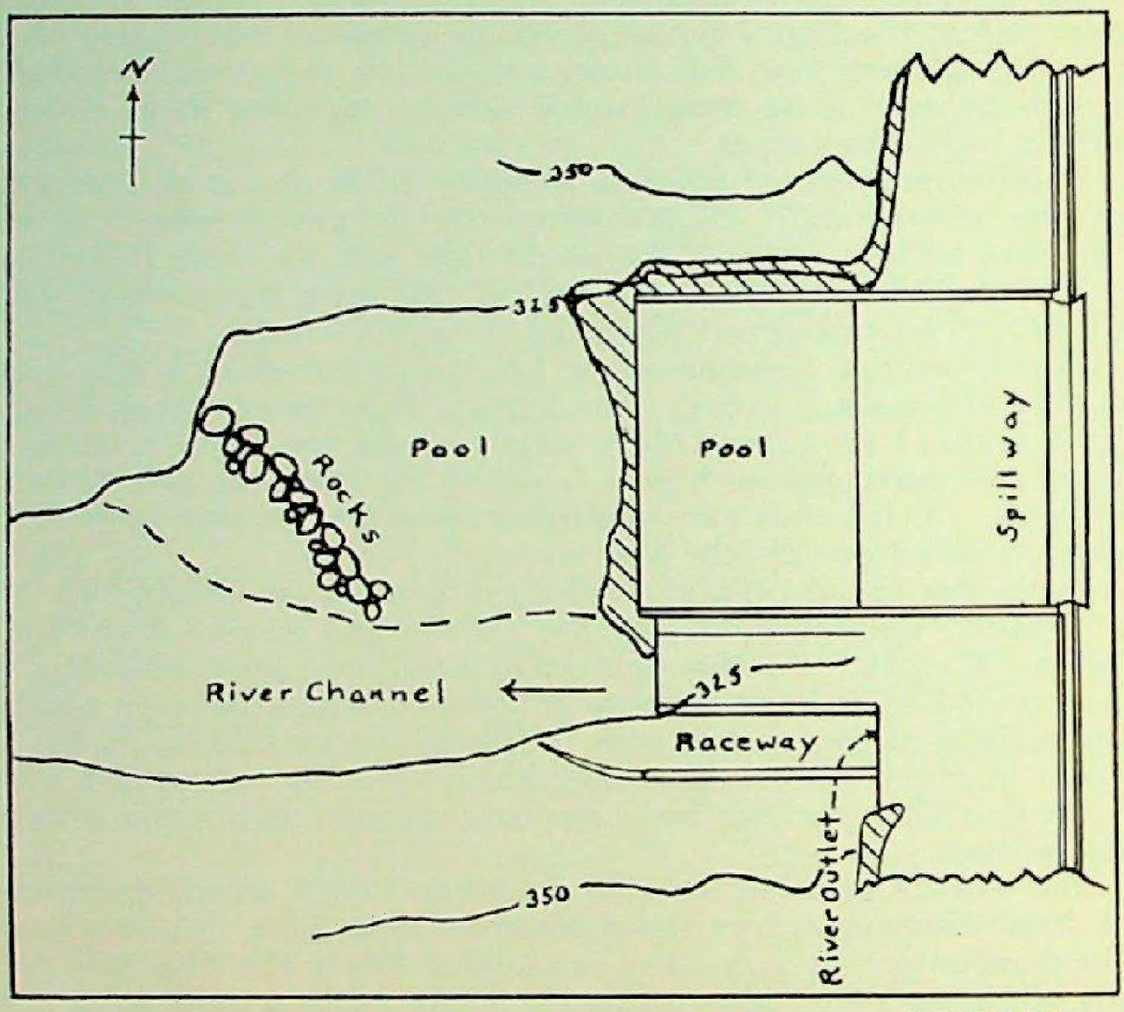
The volume of water on this date was 10,328 second-feet coming from four discharge pipes through the dam at high velocity into an inclined raceway. A large pool is situated below the dam face to the north of the raceway, into which the main spillway will pour. This pool contains nearly 70,000 square feet of water area 44 feet deep at maximum tail-water level. At lower tail-water levels the surface area of the pool decreases only slightly. Downstream below the aforementioned pool is another of almost the same area, formed by rocks thrown up in excavating, just north of the main river channel. The river flows from this pool over rocky riffles to the main channel. It is understood that these rocks will be cleared away later to prevent their being washed downstream during times of heavy flow over the spillway (Fig. 29).

Observations were again made on July 8. At this time the volume of water had decreased from that of the previous visit and salmon

[1] Submitted for publication, December, 1942.

could be seen in both of the pools, as well as in the raceway. The number of fish below the dam at that time was estimated to be approximately 5,000. These fish were in prime condition, without bruises or scars, and of good color. A few fish were injured from attempts to work up the raceway toward the discharge pipes. However, from all information obtained, the mortality was very low. Attempts were made to catch salmon to determine the maturity of the sex organs but only one male was taken, which was immature. The water temperature reached a maximum of 72° F. in July in the pool below the dam.

Subsequent observations were made on August 26, September 21, and October 7. Each observation showed the fish holding well below



By G. H. Clark

FIG. 29. Sketch of spillway section of Friant Dam, showing pools below spillway, river outlet, and raceway.

the dam. They were in good condition and were not fighting the discharge to any extent, but lay in large quiet schools. No scars or fungi were seen. Water space and volume seemed entirely adequate. The flow on August 26 was 1,533 second-feet, on September 21, 1,173 second-feet, and on October 7, 1,060 second-feet.

At each visit to the area it was observed that fewer fish were in the pools and that many had dropped away from the base of the dam downriver in search of spawning riffles. On September 21 salmon were seen spawning 10 miles below the dam. These were not new-run fish because the river had been blocked by the sand dam early in the

summer. However, they might have been spring-run salmon which had remained in pools between Lanes Bridge and Mendota.

A final visit to this area was made on November 4. All the salmon had left the pools below the dam except three pairs that were spawning in a back eddy off the main river channel. Salmon were spawning in large numbers on all the riffles observed between Friant Dam and Lanes Bridge. The condition of the fish had changed, for they had taken on the characteristic dark spawning color, were scarred and worn from fighting and digging and were fungused on all abrasions. Many dead, spawned-out salmon were noted along the banks and on the bottom of the stream. The flow of the river at Friant on November 4 seemed adequate to cover most of the spawning beds.

Insofar as known, these are the first systematic observations of the effects of blocking a spring adult salmon migration in a stream where adequate spawning beds are available a short distance below the blocking point. These observations indicate that spring salmon which are *not handled* will remain in excellent condition from spring until late fall, where *adequate space* and a *sufficient volume of water of the right temperature* are available. They also indicate that such salmon, when ready to spawn, will drop back downstream.

When the salmon appeared below Friant Dam, some fear was expressed by local residents that they would not survive. It was proposed to transfer them into the reservoir above the dam to let them spawn in the hope that land-locked chinooks would become established and furnish good sport fishing in the future. Many attempts have been made elsewhere to establish landlocked runs of king salmon. There is only one doubtful case in which a landlocked king salmon has been observed to mature. No cases of actual spawning of land-locked specimens have been noted.

Spring-run king salmon have never been handled successfully without a very high mortality. Such transfers therefore would have resulted in the death of most of the adult fish handled, and would have been a useless waste of spawning salmon. Even if some fish had been successfully transferred above the dam, many of the young salmon resulting from such transfers would probably have failed to find the main outlets to the river and would have gone down the irrigation canals.

RAPTOR PELLETS AS INDICATORS OF FOOD HABITS [1]

By Ben Glading, Daniel F. Tillotson and David M. Selleck
Bureau of Game Conservation
California Division of Fish and Game

It has been the practice among naturalists and wildlife technicians to rely on the contents of raptor pellets as a partial index of hawk and owl food habits.

Pellets are simply the indigestible parts of the hawk or owl prey, held in the stomach for some hours or days after the ingestion of a meal, and then regurgitated, usually in a compact ball. These pellets are commonly collected by researchers from beneath raptor roosts or

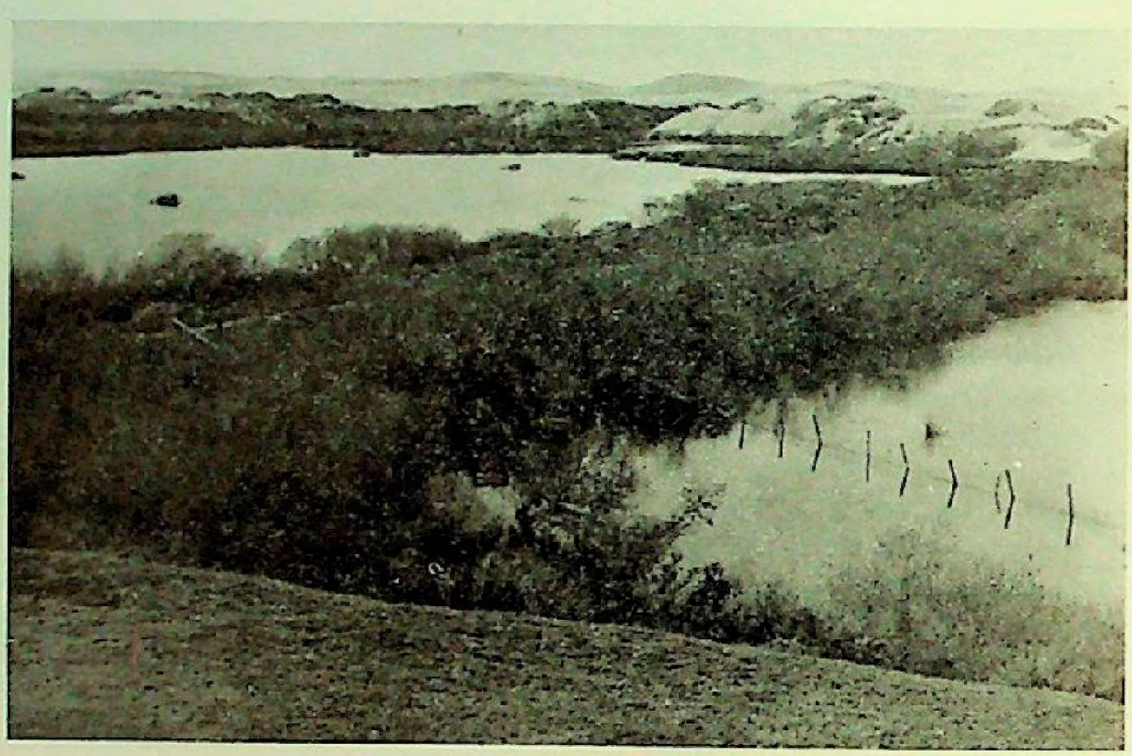


Fig. 30. Typical scene at Dune Lakes Club, California, where many of the raptors used in these experiments were obtained.

nests, and hairs, feathers, and bones found therein are examined to determine what foods have been taken by the hawk or owl in question.

It seemed to the authors that a number of factors could play a part in pellet formation, and that it was possible that some discrepancies might arise between the food actually ingested by a raptor and the food identified in pellets regurgitated from the same meals. Therefore, to test the value of pellets as food indicators, an experiment was designed wherein known foods were to be fed to various species of

[1] Submitted for publication, April, 1943.

raptors and pellets were to be collected for independent analysis by a food habits technician. Opportunity to conduct this experiment arose during the summer of 1942, when a number of young hawks and owls of various species were obtained from two of the Coast County Quail Study experimental areas. Cooperation between field workers and the Food Habits Laboratory of the Division of Fish and Game enabled this study of the reliability of pellet analysis to be undertaken.

Grateful acknowledgment is extended to Dr. Alden H. Miller, Director of the Museum of Vertebrate Zoology, University of California, for making available to us the collections of that institution.

The owners of Dune Lakes, Ltd., generously supplied pens for holding the raptors used in the experiment and have cooperated in the conduct of the general quail management and predator studies at their club.

Mr. Glading and Mr. Selleck conducted the field parts of the experiments; while Mr. Tillotson analysed the pellets.

This paper is part of a general study of valley quail management conducted under the auspices of Federal Aid in Wildlife Restoration, Project California 6-R, The Management of California Valley Quail in the South Coast Counties of California.

METHODS

In the course of a food habits and behavior study of various nesting hawks and owls at the Dune Lakes Club near Oceano and at the Shandon Experimental Area near Shandon, both in San Luis Obispo County, California, young raptors of the species listed below were taken from their nests just previous to their normal time of flight. These young, with the exception of the Cooper's hawk and the barn owl, were fully feathered and capable of tearing their own food apart. The birds were taken to prepared pens at the Dune Lakes Club.

The raptors studied were:

1. Immature western red-tailed hawk (*Buteo borealis calurus*)
2. Immature Swainson's hawk (*Buteo swainsoni*)
3. Immature Cooper's hawk (*Accipiter cooperi*)
4. Immature prairie falcon (*Falco mexicanus*)
5. Immature marsh hawk (*Circus hudsonius*)
6. Adult female marsh hawk (*Circus hudsonius*)
7. Immature barn owl (*Tyto alba pratincola*)
8. Immature horned owl (*Bubo virginianus pacificus*)
9. Immature western burrowing owl (*Speotyto cunicularis hypugaea*)

All but the adult female marsh hawk and the immature burrowing owl were carried through the complete experiment as outlined below.

The hawks and owls were caged in individual chicken wire pens approximately 2′ x 2′ x 2′ in size. Each pen was supplied with a false bottom of large mesh chicken wire so that pellets, refuse, and excreta would fall through to a collecting space below. A small wooden platform was placed at one end of each pen to hold the food.

The hawks were usually fed once a day, although in some cases food was placed in the pens two or more times a day. A list was kept of all items fed and their condition. In general, the following plan of

feeding was pursued: For one week, the raptors were fed nothing but birds; the next week, nothing but rodents; and the following week, a mixture of birds and rodents each day. In some cases, the week of rodent feeding preceded the week of bird feeding.

Since more than 500 food items were used during the experiments, some trouble was experienced in providing fresh food each day. Domestic rats and mice were obtained from snap traps in a nearby barn; squirrels were shot, and a few small rodents were taken from a weasel trap employed at the Dune Lakes Club. The bulk of the material, however, was generously supplied by three pairs of barn owls and two pairs of marsh hawks at the Dune Lakes Club. In connection with another study (Selleck and Glading, 1943), "cage nests" were placed at these wild hawk and owl nests and food brought by the adults to their young was traded by us for domestic rats and mice, of which we had an over-supply. Thus, much of the food fed to our captive birds was actually supplied by wild raptors; in fact, the parents of the young barn owl were the chief providers. This also explains why some of the items listed as fed to the captives are noted as "no head" or "fore-quarters missing," etc., since the wild adults ate these parts before bringing them to their own young.

Only items that were readily identified in the field were used, since speed of feeding precluded any careful keying down of young birds. Group names were used in most cases when listing food species. It seemed to fit our purpose to list a bird as a junco, a crowned sparrow, or a blackbird, rather than run them down to sub-species, when in all probability they would be analysed as "small Fringillids" or "young Passerines." Rodents were identified to species in the field. This grouping proved to be wise, since in no instance was an item later analysed to a finer taxonomic group in the laboratory than it was given in the field.

At feeding times the collecting space under the pens was cleaned and all pellets were sorted out and placed in individual, serially numbered envelopes, labeled as to date of collection and species of bird from which they came. All refuse and excreta were cleaned from the collecting space. The refuse was examined for unused food items or parts thereof, which, when found, were subtracted from the previous day's list of food fed.

The pellets thus obtained were sent to the Food Habits Laboratory of the California Division of Fish and Game for analysis. There, each pellet was picked to pieces dry (without soaking in water) and the items present were identified. These items were listed for each pellet and the complete results were sent to the field workers. *The methods used in the analyses were routine; no more time or effort was expended than would have been for any ordinary series of raptor pellets. At no time before or during the examination of the pellets did the food habits technician see the list of food items which had been fed to the various raptors.*

The two lists, food items fed to the raptors and food items found in the pellets, are herein presented in the original as drawn up in the field and laboratory respectively, except that in the case of the laboratory's listing scientific names have been changed to common names and re-arranged within a day's feeding for better correlation.

All items grouped in the original data, such as "three spotted towhees," have been broken up into separate entries ("spotted towhee, spotted towhee, spotted towhee") to afford better visual correlation between the two lists.

RESULTS

Complete details of foods fed to the various predators are listed for comparison with the food traces identified in the pellets in Tables 1 to 8. Tables 9 to 16 are summaries presenting the data in a form such as a food habits technician might use in reporting the analyses of a series of pellets. These summaries have been prepared by adding all individual entries appearing in the two lists and grouping them into comparable categories where possible. Items appearing in brackets in Tables 1 to 8 are omitted, since it is felt that these are residual from a period of uncontrolled feeding either in the nest or in a large holding pen in which raptors not actually under observation were held.

Barn Owl

The immature barn owl used in our experiments was obtained from a nest at the Dune Lakes Club. This bird and the young Cooper's hawk were not as well feathered as were the other raptors employed in the tests. Two weeks of the experiment had elapsed before the barn owl attained its full juvenile plumage; however, it was able to ingest food by itself from the first. It had the habit of swallowing most items whole. Pellets from this bird consisted of readily identifiable bones, hair, and feathers.

In general, the analysed contents of the barn owl's pellets were very comparable to the list of foods fed. Three types of discrepancies arose, however. It will be noted, both from Table 1 and Table 9, that more valley quail and mourning doves were fed than were counted in the pellets. These game birds were mainly very young specimens. Seven young game birds were thus fed, but failed to be represented in the pellets.

Another slight discrepancy arose from the fact that more kangaroo rats and pocket gophers were analysed in the pellets than were actually fed. This source of error arises when the traces of one food item are distributed over two or more pellets. While individual items were counted within a single pellet by means of enumerating the number of skulls or femurs found, no such attempt was made to count skulls or other skeletal parts of individuals distributed through several pellets.

Another error, understandable, but nettling to the laboratory technician, was the misidentification of a bantam chick as a young valley quail.

Pacific Horned Owl

The horned owl was obtained from a nest near Shandon. It was fed in a desultory manner for several weeks before the start of the experiment. One pellet was collected during this time, but since the complete experiment was not begun until the first of June, none of this early feeding is considered here. It will be noted that the first pellet listed in Table 2 is Pellet No. 2.

A study of Table 2 will reveal that while foods fed were fairly well represented in the pellets, the correlation is not as good as in the case of the barn owl. No pellets were found on June 12, 13 or 14, resulting in a total lack of representation of articles fed on June 11 and 12. Another source of error is that multiple individual items fed did not come through in the pellets in comparable quantities; the 9 house mice fed on June 8 were counted in the analyses as 5. Some young birds failed to be represented; this was true in the case of the 3 immature house finches fed on June 7.

This owl tended to distribute remnants of a particular food item among several pellets. The most extreme example of this occurred in the case of a mourning dove fed on June 30, which appeared in four successive pellets on July 1 to 4, inclusive.

Another interesting example of the "holdover" of a food item occurred when one shrike was fed on June 14. The bulk of this shrike, including only one humerus, appeared in a pellet on June 15; the complementary humerus did not appear in a pellet until July 1, when it was the only trace of a shrike present.

Table 10, the summary of foods fed to the horned owl, indicates that the general proportion of items fed agrees fairly well with food traces found in pellets.

Western Burrowing Owl

The burrowing owl was taken from a nest near Shandon. It was noted that the bones contained in its pellets were badly broken, making identification of food traces more difficult than in the case of the other two owls. Unfortunately, this owl did not live to complete the experiment, since it accidentally broke its beak on June 24 and died two days later. Tables 3 and 11 seem to indicate that this owl is intermediate between the other owls and hawks in the matter of pellet reliability.

Marsh Hawk

This hawk was taken from one of the "cage nests" in a marsh at the Dune Lakes Club. Its pellets were composed almost entirely of hair and feathers, little bone being present. This characteristic was general throughout the hawks studied.

The complete list of foods fed this hawk will be found in Table 4 and the summary of all items in Table 12. Throughout the lists many items that were fed are simply not to be found in the list of food traces discovered in the pellets. In addition to this lack of representation in pellets, many items that were represented were very difficult to identify since but a small portion of the animal was represented. Bones were almost never present and identification had to be made from hair or feathers in nearly all cases

A tendency that was noted in practically all the hawks, with the exception of the Cooper's hawk, was that kangaroo rats were poorly represented in the pellets even though fairly large numbers of them were fed. In the case of the marsh hawk, three kangaroo rats fed did not show at all in the food traces found in pellets. It was also noted the five young game birds (quail and doves) that were fed did not come through in pellets.

While the general proportion of birds to rodents seems to be correlated very well in Table 12, a detailed examination of Table 4 and individual item summaries in Table 12 indicates that this correlation is accidental. It is unfortunate that we have not been able to devise a statistical means of testing these proportions of birds to rodents.

An adult female marsh hawk, the mother of the immature bird discussed above, was also caged at the start of the experiment and attempts were made to get her to take a list of foods similar to those fed the young hawk. All attempts to get this bird to eat met with failure and no pellets were recovered.

Cooper's Hawk

The Cooper's hawk was likewise taken from a "cage nest" near the Dune Lakes Club. This bird, as in the case of the barn owl, was somewhat younger than the general run of raptors used in the experiment. It was not until about July 1st that this bird reached its full juvenile plumage.

Tables 5 and 13 reveal that many items fed to this hawk failed to be represented in the pellets. It will also be noted that rodents were proportionately better represented in the pellets than were birds. A study of the other summaries will reveal that this is true in the case of some of the other hawks.

Prairie Falcon

The prairie falcon came from a nest near Shandon. Its pellets consisted of hair or feathers and were appreciably smaller than in the case of most of the other hawks.

Tables 6 and 14 give the extended list of food items fed and identified in pellets and a summary of these items. It will be noted that four game birds fed did not appear in the pellets, even as traces. In general, many items fed failed to be represented in the pellets.

Red-tailed Hawk

This hawk came from a "cage nest" near Shandon. Its pellets lacked bones. As in the case of most of the hawks the correlation between foods fed and foods identified was poor. In Table 7 an extreme example of a type of error inherent in hawk pellets is present. From July 3 to July 6, inclusive, there were 17 blackbirds, two brown towhees, and one California thrasher fed. These items showed up as two blackbirds and two thrashers in the list of pellet items. Thus a percentage list of foods fed during this period would be as follows: 85 per cent blackbirds, 10 per cent brown towhees, 5 per cent thrashers; while the food habits list prepared from the pellets would be 50 per cent blackbirds and 50 per cent thrashers.

Swainson's Hawk

This hawk likewise came from near Shandon. In the physical characteristics of the pellets and in the representation of food items in the pellets, the Swainson's hawk was very similar to the red-tailed hawk.

Lists and summaries of foods fed and identified will be found in Tables 8 and 16. It will be noted that nine kangaroo rats fed to the Swainson's hawk came through as three in pellets.

Many additional discrepancies in the hawk pellets, other than those specifically mentioned under the species accounts, will be found in the various tables. Lack of space precludes the complete listing of these. A discussion of the possible causes of the lack of correlation between foods fed and foods identified will be found below.

DISCUSSION

Brooks (1929) called attention to the possibility that hawk and owl pellets were subject to question in their use as food habits indicators. Errington (1930, 1932) conducted experiments on laboratory feeding in various raptors. His conclusions were generally in agreement with ours in that the owls tested by him were considered to give pellets that were good indicators, whereas the hawk pellets were not so reliable. Chitty (1938) made a detailed study of the pellet formation of the short-eared owl and made similar conclusions.

A study of Tables 1 to 8 indicates that the pellet contents were in no instance entirely reliable as representative of foods fed. The reliability of the pellets graded from a good correlation of foods fed to foods identified in the case of the barn owl, down to poor correlations in the hawks.

The principal factor in accuracy of analyses seems to be the presence or absence of bones in the pellets. Owl pellets contain quantities of undigested bones, represent a larger quantity of foods fed, and items are, therefore, more accurately identified and enumerated than in the case of hawk pellets which contain almost no bones.

In addition to this element of presence or lack of bones, there seem to be many other sources of error inherent in the general methods employed in pellet analyses. Some of the possible errors involved are outlined below. The first three categories are peculiar to the present study.

I. Human Errors Involved in Pellet Studies

A. Field Errors

1. Stray hairs or feathers remaining in cage

There is the possibility that particles of hair or feathers from one item will remain in the cage and will be eaten along with another meal several days later, or attach themselves to the outside of pellets. Care was taken to avoid this. This factor is more possible with hawks that have the habit of tearing their prey apart before swallowing it, than with owls that prefer to swallow small prey whole. Care was taken to keep the cages clean in this study and it is felt that if this error is present it is exceedingly minor. This possible error is, of course, peculiar to this type of experiment.

2. Failure to find pellets in debris

As explained under "Methods," every care was taken to guard against this possibility. It is felt that this source of error is negligible. This is also peculiar to this type of study. While it is barely

possible that the lack of pellets on June 18 and 20 in the marsh hawk experiment (Table 4) was due to the fact that they were lost in the debris, a thorough search was made each day, and it is believed that in every instance of lack of pellets, none were found because none were present.

3. Possibility that items not listed in diet carry over into the pellets studied

It will be noted (see Tables 2, 4, and 7) that in the various summaries of foods identified certain items are contained in brackets. These items are felt to be residual from a period of uncontrolled feeding, either in the nest or in the large pen in which raptors were held while not actually under observation. Most of these residual items have probably been discovered and so noted in this study, but there remains a possibility that items similar to those fed in the controlled feeding have carried over into the pellets. Ideally, the raptors should be fed for some days prior to the actual start of the study on a base diet of, let us say, rabbits. Then, during the course of the controlled feeding, no rabbits should be used.

4. Errors in collecting pellets in the field

This error is not truly germane to the present paper but is included here for completeness.

Misidentification of pellets according to species of raptor which regurgitated them is possible. Horned owl and barn owl pellets are, for all practical purposes, indistinguishable, while it is absolutely impossible to identify the origin of hawk pellets from the appearance of the pellet alone. Unless the origin is absolutely certain, and this is impossible in most cases, field pellets had best be discarded.

Another error constantly perpetrated in pellet analyses is that of taking pellets from a roost, analysing them, and tabulating the results as typical of the food habits of the raptor in question. In most cases, this procedure ignores the fact that the hawk's or owl's food habits may change seasonally. One hawk, which might have a clean record as far as leaving birds alone in the winter is concerned, might find nestling birds a prime dietary factor in the spring and early summer when it changes roosts and foraging territory.

B. Errors in the Laboratory

1. Difficulty in enumerating the number of individual items in a pellet

Examples of this seem to be frequent in the experiments here presented. It is far simpler to count individual prey items of the same species in owl pellets than in hawk pellets. Skull parts may be readily checked and counted when present in owl pellets, but to try to estimate whether or not the ball of hair in question came from one or ten meadow mice is subject to considerable error. That errors in counting individuals in pellets are probably present in this study is evident from an examination of almost any one of the tables presented. On June 8, 9 house mice were fed to the horned owl (Table 2). These were represented in the pellets as 5 house mice. Seventeen red-winged blackbirds, fed to the red-tailed hawk July 3 to 6, were represented in the pellets as 2 blackbirds (Table 7). Other such examples may be found in any of the tables.

2. Failure to examine every hair or feather in a pellet

A food habits technician confronted with a series of pellets can not take the time in a routine analysis to examine every hair under the microscope. Hairs are grouped macroscopically and then examined more minutely for final identification. In some cases, similar hairs are placed in the same group, causing two species to be identified as one individual. This type of error may have been the cause of missing, let us say, the white-footed mouse fed to the Swainson's hawk on July 5, which was not represented in corresponding pellets.

3. Lack of knowledge of differentiating characters

In the instance of young birds in particular, no key for differentiating feathers of the Passerine species is available. This is of little consequence to a game management student, but may be of prime importance in certain studies. Cricetine rodents [harvest mouse (*Reithrodontomys* sp.) and white-footed mouse (*Peromyscus* sp.) in our experiments] are difficult to separate from hairs alone. This has given rise to a few minor errors.

4. Misidentification of items

This factor is partly corollary to the above, but some grosser errors are possible. (See under barn owl where a juvenile bantam chicken was identified as a young valley quail.)

II. Errors Due to the Physiology of Pellet Formation by the Raptor

A. Holding Items Over for Several Days

That this has happened in our experiments is evident throughout. Of course, this factor, like the others discussed below, might be influenced or aggravated by the fact that the birds used were caged and hence out of their natural environment. Nonetheless, the tendency is present and it remains for those who insist on regarding pellet analyses as fool proof to prove that it does not exist under natural conditions. In practically every case where this occurred, traces of the item fed appeared in more than one pellet. (See Table 2 where one mourning dove, fed on June 30, appeared in pellets as late as July 4. One shrike fed on June 14, appeared in one pellet on June 15 and later one bone appeared in a pellet on July 1.)

B. Eating Fleshy Parts Only

This has happened in the case of prey items such as ground squirrels, rabbits, and possibly kangaroo rats. It was observed that the raptors ate the viscera and muscles of these larger foods but not much, if any, of the hair. Since no "roughage" was present to form a pellet, none was formed. Examples of this will be noted in Table 6, where a brush rabbit and a ground squirrel were fed to the prairie falcon and only the fleshy parts eaten. No traces were found in the pellets.

C. Not Regurgitating Pellets

This factor is difficult to prove to a skeptical reader, but in the case of almost every predator tested, some days passed without the appearance of a pellet. Items which should have been in the missing pellet simply never showed up in most cases. This seems to be the case in the horned owl from June 12 to 14, when no pellets were found, in the case of the red-tailed hawk on July 4 and 5, and in many other instances. What caused this is beyond the realm of this paper.

D. Regurgitating Some Items in a Meal and Passing Others Through the Intestinal Tract

This trait seeems to be most evident in the case of young birds eaten with other items or by themselves. While it has not been proven by these experiments that the down and soft bones pass on into the intestine, their absence from the pellets seems to indicate that this is the case. Even the barn owl (Table 1) seems not to regurgitate these very young items, as is evidenced by the fact that some young quail and doves were missing from the pellets.

E. Possibility of Secondary Prey Appearing in Pellets

This source of error is probably not present to any great extent in the present series of pellets since no carnivorous birds, mammals, or reptiles were fed. However, in nature many of the hawks eat snakes as a regular part of the diet, and it is very likely that some of the prey listed in such a series of pellets could more properly be ascribed to the snake than to the raptor. It is possible that some of the ground squirrels and rats used in this study had been feeding on carrion and hence would introduce another possible, although slight, error. No clear cut evidence of this can be given in these experiments.

F. Possibility That Some Types of Hairs Will Not "Ball-up" to Form Pellets

It is possible that kangaroo rat hair, which is readily identifiable, slips through with the digested food due to its stiffness and polished exterior. At least this is one explanation of the fact that whereas a total of 24 kangaroo rats were fed to the marsh hawk, prairie falcon, red-tailed hawk, and Swainson's hawk, only eight traces of kangaroo rat were found in the pellets.

G. Possibility of the Raptor Ingesting Some of Its Own Feathers

This could be a pitfall for an inexperienced food habits research man.

It is difficult in every case of a particular discrepancy to say definitely just which of the above sources of error is present.

SUMMARY AND CONCLUSIONS

1. Individuals of eight species of hawks and owls were penned, fed a varied diet, and pellets collected from these birds were analyzed in ignorance of the original list of foods fed. These two lists, foods fed and foods traces found, are herein compared.

2. Barn owl and horned owl pellets, which contain bones in addition to hair and feathers, were found to be fairly good indicators of food habits. It must be realized, however, that they are not perfect and that among other inherent errors, young birds are not fairly represented in the pellets.

3. The pellets of the hawks tested were unreliable as a quantative indication of food habits. Even a rough qualitative list of items found in hawk pellets is open to question as being truly representative of items eaten.

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TABLE 1

BARN OWL

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 10	fledgling	Goldfinch	*Goldfinch*	#1	June 11
	juvenile	House Finch	*House Finch*		
	fledgling	Spotted Towhee	*Young Bird*		
	fledgling	Spotted Towhee	*Young Bird*		
	fledgling	Spotted Towhee	*Young Bird*		
	juvenile	Crowned Sparrow			
June 11		Junco	*Small Fringillid Bird*	#2	June 12
	11 days old	Valley Quail	*Very Young Valley Quail*		
	12 days old	Valley Quail	*Very Young Bird (Probably Valley Quail)*		
			Very Young Bird (Probably Valley Quail)		
June 12	7 days old	Mourning Dove	*Young Bird*	#3	June 13
	7 days old	Mourning Dove			
	4 days old	Valley Quail			

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TABLE 1—Continued

BARN OWL

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 13	fore-end only	Mourning Dove	*Mourning Dove*	#4	June 14
		Goldfinch	*Small Fringillid (Goldfinch?)*		
		Goldfinch	*Small Fringillid (Goldfinch?)*		
		Goldfinch	*Small Fringillid (Goldfinch?)*		
	juvenile	Valley Quail			
	juvenile	Valley Quail			
	juvenile	Valley Quail			
	14 days old	Valley Quail			
June 14	no head	Red-winged Blackbird	*Passerine Bird (Prob. Blackbird)*	#5	June 15
	juvenile	Valley Quail	*Very Young Valley Quail*		
	juvenile	Valley Quail	*Very Young Valley Quail*		
June 15		Mourning Dove	*Mourning Dove*	#6	June 16
	14 days old	Mourning Dove	*Very Young Valley Quail*		
	14 days old	Valley Quail	*Very Young Valley Quail*		
	10 days old	Valley Quail			
	10 days old	Valley Quail			
June 16		Kangaroo Rat	*Kangaroo Rat*	#7	June 17
		Kangaroo Rat	*Kangaroo Rat*		
		Mole			
			Kangaroo Rat	#8	June 17
			Mole		
June 17		Pocket Gopher	*Pocket Gopher*	#9	June 18
		Pocket Gopher	*Pocket Gopher*		
			Pocket Gopher	#10	June 18
			Kangaroo Rat		
June 18		Kangaroo Rat	*Kangaroo Rat*	#11	June 19
		Pocket Gopher	*Pocket Gopher*		
June 19	immature	Kangaroo Rat	*Kangaroo Rat*	#12	June 20
	immature	Pocket Gopher	*Pocket Gopher*		
		White-footed Mouse	*White-footed Mouse*		
June 20		Kangaroo Rat	*Kangaroo Rat*	#13	June 21
June 21		Pocket Gopher	*Pocket Gopher*	#14	June 22
	parts not eaten	White-footed Mouse	*White-footed Mouse*		
June 22		Domestic Rat	*Domestic Rat*	#15	June 23
		White-footed Mouse	*White-footed Mouse*		
June 23 to July 7	held in large holding pen, food not recorded		*[Rodent, Squirrel]*	#16	July 8
July 8	juvenile	Chicken (Bantam)	*Meadow Mouse*	#17	July 9
		Meadow Mouse			
July 9		Pocket Gopher	*Valley Quail (Young)*	#18	July 10
		White-footed Mouse	*Pocket Gopher*		
	immature	House Finch	*White-footed Mouse*		
July 10		Pocket Gopher	*Young Bird*	#19	July 11
		White-footed Mouse	*Pocket Gopher*		
			White-footed Mouse		
July 11		Brown Towhee	*Brown Towhee*	#20	July 12
		White-footed Mouse	*White-footed Mouse*		
July 12		Meadow Mouse	*Meadow Mouse*	#21	July 13
	no head	Red-winged Blackbird	*Blackbird*		
July 13		Pocket Gopher	*Pocket Gopher*	#22	July 14
		Goldfinch	*Small Fringillid (Goldfinch?)*		

TABLE 2

PACIFIC HORNED OWL

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 3	adult	House Finch	[Rodent]	#2	June 5
	adult	House Finch	*Small Bird*		
		Ground Squirrel	*Ground Squirrel*		
June 4	partly eaten	Cottontail Rabbit			
June 5	refused all food		*Ground Squirrel*	#3	June 6
June 6	partly eaten	Ground Squirrel			
June 7	immature	House Finch	*Ground Squirrel*	#4	June 8
	immature	House Finch			
	immature	House Finch			
June 8		House Finch	*House Finch*	#5	June 9
		House Mouse	*House Mouse*		
		House Mouse	*House Mouse*		
		House Mouse	*House Mouse*		
		House Mouse	*House Mouse*		
		House Mouse	*House Mouse*		
		House Mouse			
		House Mouse			
		House Mouse			
		House Mouse			
June 9		King Bird	*King Bird*	#6	June 10
June 10		White-footed Mouse	*Small Rodent*	#7	June 11
		House Finch	*Bird*		
		House Finch			
June 11		White-footed Mouse			
		White-footed Mouse			
		House Finch			
June 12		White-footed Mouse			
		House Mouse			
June 13	refused all food				
June 14		Shrike	*Shrike*	#8	June 15
		Meadow Lark	*Meadow Lark*		
			Meadow Lark	#9	June 15
June 14 to June 19	held in large holding pen, food not recorded				
June 20	partly eaten	Ground Squirrel			
June 21	refused all food		*Ground Squirrel*	#10	June 22
June 22		Wood Rat	*Ground Squirrel*	#11	June 23
		Meadow Mouse	*Wood Rat*		
			Meadow Mouse		
June 23		Kangaroo Rat	*Kangaroo Rat*	#12	June 24
		White-footed Mouse	*White-footed Mouse*		
June 24	immature	Brush Rabbit	*Rabbit (Immature)*	#13	June 25
June 25		Meadow Mouse	*Meadow Mouse*	#14	June 26
		Meadow Mouse	*Meadow Mouse*		
		Pocket Gopher	*Pocket Gopher*		
		Pocket Gopher	*Pocket Gopher*		
		White-footed Mouse			
	immature	Kangaroo Rat			
June 26		Meadow Mouse	*Meadow Mouse*	#15	June 27
		Pocket Gopher	*Pocket Gopher*		
		White-footed Mouse	*White-footed Mouse*		

TABLE 2—Continued

PACIFIC HORNED OWL

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 27		Pocket Gopher	*Pocket Gopher*	#16	June 28
		Meadow Mouse	*Meadow Mouse*		
		Kangaroo Rat	*Kangaroo Rat*		
		Kangaroo Rat			
June 28		House Finch	*Pocket Gopher*	#17	June 29
		House Finch	*Meadow Mouse*		
		House Finch	*Kangaroo Rat*		
		House Finch	*Ground Squirrel*		
	21 days old	Valley Quail	*House Finch*		
			House Finch		
			Valley Quail		
June 29		Meadow Lark	*Meadow Lark*	#18	June 30
		House Finch			
June 30		Mourning Dove	*Valley Quail (Young)*	#19	July 1
		Blackbird	*Mourning Dove*		
		Blackbird	*Shrike*		
			Passerine Bird		
			Passerine Bird		
July 1		Blackbird	*Mourning Dove*	#20	July 2
		Blackbird	*Passerine Bird (Prob. Blackbird)*		
		Blackbird	*Passerine Bird (Prob. Blackbird)*		
July 2		California Thrasher	*Mourning Dove*	#21	July 3
		Blackbird	*Thrasher (One or two)*		
			Blackbird		
			Blackbird		
			Passerine Bird		
July 3		Brewer Blackbird	*Mourning Dove*	#22	July 4
			Blackbird		
July 4		Mourning Dove	*Mourning Dove*	#23	July 5
		Blackbird	*Blackbird*		
		Blackbird	*Blackbird*		
		Blackbird	*Blackbird*		
		Blackbird	*Blackbird*		
July 5		Blackbird	*Mourning Dove*	#24	July 6
		Blackbird	*Blackbird*		
		Blackbird	*Blackbird*		
	head only	Blackbird	*Blackbird*		
	head only	Blackbird	*Blackbird*		
July 6		Brown Towhee	*Blackbird*	#25	July 7
			Blackbird		
			Passerine Bird		

TABLE 3

WESTERN BURROWING OWL

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 19	parts only	Ground Squirrel			
June 20		House Mouse	*Ground Squirrel*	#1	June 21
	immature	House Finch	*House Mouse*		
	immature	House Finch	*Bird*		
	immature	House Finch			
	immature	House Finch			
June 21	no head	Blackbird	*Young Passerine Bird*	#2	June 22
	14 days old	Valley Quail			
June 22	refused all food				
June 23		House Finch	*House Finch*	#3	June 24
June 24		House Finch	*House Finch*	#4	June 25
	immature	Meadow Lark			
	(At this point the burrowing owl broke its bill and refused all food. It died several days later, giving its last pellet on June 26.)		*Small Passerine Bird*	#5	June 26

TABLE 4

MARSH HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 9		House Mouse	*[Fence Lizard]*	#1	June 10
			[Bird (Passerine?)]		
			Rodent		
June 10	juvenile	Domestic Rat	*Domestic Rat*	#2	June 11
		House Mouse			
June 11	juvenile	Domestic Rat	*Domestic Rat*	#3	June 12
		House Mouse			
		House Mouse			
		House Mouse			
		White-footed Mouse			
June 12	juvenile	Domestic Rat	*Rodent (Muridae)*	#4	June 13
	juvenile	Domestic Rat			
		Kangaroo Rat			
			Domestic Rat	#5	June 13
June 13		Meadow Mouse	*Meadow Mouse*	#6	June 14
	juvenile, front only	Ground Squirrel	*Rodent*		
			House Finch?		
June 14		Brush Rabbit	*Rabbit*	#7	June 15
		House Mouse			
		House Mouse			

TABLE 4—Continued

MARSH HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 15	juvenile	Domestic Rat	*Domestic Rat*	#8	June 16
		House Mouse	*House Mouse*		
	no head	Brush Rabbit			
June 16		House Finch	*Passerine Bird*	#9	June 17
		Blackbird			
June 17		Meadow Lark			
		Song Sparrow			
June 18		Blackbird	*Passerine Bird*	#10	June 19
	no head	Meadow Lark			
June 19		Blackbird			
	immature	House Finch			
	immature	House Finch			
		Red-winged Blackbird			
	18 days old	Valley Quail			
June 20		Blackbird	*Red-winged Blackbird*	#11	June 21
	10 days old	Mourning Dove	*Bird*		
	4 weeks old	Valley Quail			
		House Finch			
June 21		Meadow Lark			
		Kingbird			
	no head or legs	Mourning Dove			
			Passerine Bird	#12	June 23
June 23 to July 13	held in large holding pen, food not recorded				
July 14		Kangaroo Rat	[*Pocket Gopher*]	#13	July 15
	juvenile	Blackbird	[*Rabbit*]		
			Passerine Bird		
July 15	adult female	House Finch	*Passerine Bird*	#14	July 16
		Kangaroo Rat			
July 16		Pocket Mouse	*Pocket Mouse*	#15	July 17
	juvenile	Blackbird			
July 17		Meadow Mouse	*Meadow Mouse*	#16	July 18
		Junco	*Passerine Bird*		
July 18		Meadow Mouse	*Meadow Mouse*	#17	July 19
		Red-winged Blackbird	*Red-winged Blackbird*		
July 19		Pocket Gopher	*Pocket Gopher*	#18	July 20
		Mourning Dove	*Bird*		
July 20		Meadow Mouse	*Meadow Mouse*	#19	July 21
	adult female	House Finch	*Sparrow*		

TABLE 5

COOPER'S HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 9		House Mouse	[Bird]	#1	June 10
			House Mouse		
June 10		House Mouse	[Bird]	#2	June 11
		House Mouse	*House Mouse*		
		House Mouse			
June 11		House Mouse	[Bird]	#3	June 12
		House Mouse	*House Mouse*		
		House Mouse			
		House Mouse			
June 12		House Mouse	*House Mouse*	#4	June 13
	immature	Domestic Rat	*Domestic Rat*		
	immature	Domestic Rat			
June 13		Pocket Gopher	*Rodent*	#5	June 14
	hindquarters only	Ground Squirrel	*Squirrel*		
			[Bird]		
June 14	immature	Domestic Rat	*Ground Squirrel*	#6	June 15
		Pocket Gopher	*Pocket Gopher*		
			[Bird]		
June 15		House Mouse	*Ground Squirrel*	#7	June 16
		Meadow Mouse	*House Mouse*		
			Meadow Mouse		
			Pocket Gopher		
June 16	wings and feet not eaten	Blackbird	*Passerine Bird*	#8	June 17
	5 days old	Mourning Dove			
June 17	no head	Blackbird			
	no head	Blackbird			
June 18		Blackbird	*Passerine Bird*	#9	June 19
	no head	Meadow Lark			
	6 days old	Valley Quail			
June 19	no head	Blackbird			
	no head	Blackbird			
	immature	House Finch			
		Mourning Dove			
June 20		Blackbird	*Passerine Bird*	#10	June 21
		Blackbird	*House Finch*		
		House Finch			
		House Finch			
June 21		House Finch	*Passerine Bird*	#11	June 22
	no head	Blackbird			
June 22	no head	Mourning Dove	*Mourning Dove*	#12	June 23
June 23 to July 13	held in large holding pen, food not recorded				
July 14	half eaten	Kangaroo Rat	[Rabbit]	#13	July 15
July 15		Kangaroo Rat	*Kangaroo Rat*	#14	July 16
		Junco			
July 16		White-footed Mouse	*Kangaroo Rat*	#15	July 17
	immature	Blackbird	*White-footed Mouse*		
			Bird		
July 17		White-footed Mouse	*White-footed Mouse*	#16	July 18
		Junco	*Bird*		

TABLE 5—Continued

COOPER'S HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
July 18		White-footed Mouse Red-winged Blackbird	*White-footed Mouse*	#17	July 19
July 19		Red-winged Blackbird Kangaroo Rat	*Red-winged Blackbird*	#18	July 20
July 20		Harvest Mouse Crowned Sparrow	*Red-winged Blackbird* *Harvest Mouse* *Bird* *White-footed Mouse* *Kangaroo Rat*	#19	July 21

TABLE 6

PRAIRIE FALCON

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 18	partly eaten	Brush Rabbit			
June 20	partly eaten	Ground Squirrel			
June 21	immature 14 days old	Brown Towhee Valley Quail	*Passerine Bird*	#1	June 22
June 22		House Finch House Finch Goldfinch Red-winged Blackbird	*Passerine Bird*	#2	June 23
June 23	 16 days old	House Finch Valley Quail	*Passerine Bird*	#3	June 24
June 24	 6 days old immature	Red-winged Blackbird Goldfinch Mourning Dove Brown Towhee	*Red-winged Blackbird*	#4	June 25
June 25	 	Red-winged Blackbird Red-winged Blackbird			
June 26	 female female 	House Finch House Finch Red-winged Blackbird Red-winged Blackbird California Thrasher	*House Finch?* *Passerine Bird*	#5	June 27
June 27	 7 weeks old, no head 	Red-winged Blackbird Red-winged Blackbird Valley Quail House Finch	*Red-winged Blackbird*	#6	June 28
June 28	no head no head	Kangaroo Rat White-footed Mouse White-footed Mouse Meadow Mouse Meadow Mouse	*Red-winged Blackbird* *Meadow Mouse*	#7	June 29
June 29	 	Harvest Mouse Meadow Mouse Pocket Gopher	*Red-winged Blackbird* *Meadow Mouse* *Pocket Gopher*	#8	June 30
June 30	front end only parts of parts of	White-footed Mouse Kangaroo Rat Meadow Mouse Meadow Mouse	*White-footed Mouse*	#9	July 1
July 1	 	Kangaroo Rat Harvest Mouse	*Meadow Mouse*	#10	July 2
July 2	 	Pocket Gopher	*Pocket Gopher*	#11	July 3
July 3	 	White-footed Mouse Harvest Mouse Pocket Mouse	*Harvest Mouse?* *Pocket Mouse*	#12	July 4
July 4	 	Kangaroo Rat White-footed Mouse Harvest Mouse 	*Kangaroo Rat* *Meadow Mouse* *Harvest Mouse?* *Passerine Bird*	#13	July 5
July 5	 	Meadow Mouse White-footed Mouse Harvest Mouse	*Meadow Mouse*	#14	July 6

TABLE 6—Continued

PRAIRIE FALCON

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
July 6		Meadow Mouse White-footed Mouse	*Meadow Mouse*	#15	July 7
July 7		Red-winged Blackbird Kangaroo Rat Harvest Mouse	*Red-winged Blackbird* *Kangaroo Rat*	#16	July 8
July 8		Kingbird White-footed Mouse Harvest Mouse Harvest Mouse	*Passerine Bird* *Small Cricetine Rodent*	#17	July 9
July 9	immature	Red-winged Blackbird House Finch Meadow Mouse Pocket Mouse	*Red-winged Blackbird*	#18	July 10
July 10		Brown Towhee Kangaroo Rat Pocket Mouse Harvest Mouse	*Passerine Bird* *Kangaroo Rat* *White-footed Mouse*	#19	July 11
July 11		House Finch Meadow Mouse White-footed Mouse	*House Finch* *Meadow Mouse*	#20	July 12
July 12		Red-winged Blackbird Pocket Gopher	*Red-winged Blackbird*	#21	July 13
July 13		Goldfinch Meadow Mouse	*Passerine Bird* *Meadow Mouse*	#22	July 14

TABLE 7

WESTERN RED-TAILED HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 21		House Mouse	[*Passerine Bird*]	#1	June 23
	hind-quarters only	Ground Squirrel	*Rodent (Muridae)*		
	hind-quarters only	Pocket Gopher			
June 22	head and hide left	Domestic Rat			
		Meadow Mouse			
June 23	immature	Brush Rabbit	*Meadow Mouse*	#2	June 24
			Rabbit		
June 24		Kangaroo Rat	*Rabbit*	#3	June 25
			Kangaroo Rat		
			[*Passerine Bird*]		
June 25		Pocket Gopher	*Pocket Gopher*	#4	June 26
		Pocket Gopher	*Meadow Mouse*		
		Pocket Gopher			
		Meadow Mouse			
		Kangaroo Rat			
June 26		Meadow Mouse	*Meadow Mouse*	#5	June 27
		Pocket Gopher	*Pocket Gopher*		
		White-footed Mouse			
		White-footed Mouse			
June 27		Pocket Gopher	*Pocket Gopher*	#6	June 28
		Meadow Mouse	*Meadow Mouse*		
		Kangaroo Rat	*Kangaroo Rat*		
		Kangaroo Rat			
June 28		House Finch	*Small Passerine Bird*	#7	June 29
		House Finch			
		House Finch			
		House Finch			
	21 days old	Valley Quail			
June 29	fledgling	Valley Quail	*Gallinaceous Bird*	#8	June 30
		House Finch			
June 30		Brewer Blackbird	*Blackbird*	#9	July 1
		Brewer Blackbird			
		Brewer Blackbird			
July 1		Red-winged Blackbird	*Red-winged Blackbird*	#10	July 2
		Red-winged Blackbird			
	immature	Unidentified Sparrow			
July 2	7 weeks old	Valley Quail	*Bird*	#11	July 3
July 3		Brown Towhee			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
July 4		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
July 5		California Thrasher	*Thrasher*	#12	July 6
		Red-winged Blackbird	*Red-winged Blackbird*		
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			
		Red-winged Blackbird			

TABLE 7—Continued

WESTERN RED-TAILED HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
July 6		Red-winged Blackbird	*Thrasher*	#13	July 7
		Red-winged Blackbird	*Red-winged Blackbird*		
		Brown Towhee			
July 7		Pocket Gopher	*Pocket Gopher*	#14	July 8
		Junco	*Passerine Bird*		
July 8		Red-winged Blackbird	*Red-winged Blackbird*	#15	July 9
		Kangaroo Rat	*Rodent*		
	immature	Pocket Gopher			
July 9		Domestic Rat	*Domestic Rat*	#16	July 10
		Pocket Mouse			
July 10		Meadow Mouse	*Meadow Mouse*	#17	July 11
		Kangaroo Rat	*Passerine Bird*		
		Junco			
July 11		Meadow Mouse	*Meadow Mouse*	#18	July 12
		Brown Towhee	*Passerine Bird*		
July 12		Pocket Gopher	*Rodent (Muridae)*	#19	July 13
		House Finch	*Passerine Bird*		
July 13		Wood Rat	*Rodent*	#20	July 14
		House Finch	*Bird*		

TABLE 8

SWAINSON'S HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
June 20	immature	Domestic Rat	*Domestic Rat*	#1	June 21
June 21		Blackbird	*Bird (Non-game Woodpecker?)*	#2	June 22
	14 days old	Valley Quail			
June 22	no head	Blackbird			
		Blackbird			
	no head	Meadow Lark			
June 23	immature	Crowned Sparrow	*Bird (Non-game)*	#3	June 24
		Western Kingbird			
June 24		Blackbird	*Blackbird*	#4	June 25
		Goldfinch			
		Lark Sparrow			
		Mourning Dove			
June 25	16 days old	Valley Quail			
		Spotted Towhee			
	immature	Meadow Lark			
June 26		Red-winged Blackbird	*Passerine Bird (Blackbird?)*	#5	June 27
		Red-winged Blackbird			
		Red-winged Blackbird			
	immature	Unidentified Sparrow			
June 27		Blackbird	*Red-winged Blackbird*	#6	June 28
		Blackbird			
		Blackbird			
		House Finch			
June 28		White-footed Mouse	*Passerine Bird (Blackbird?)*	#7	June 29
		Kangaroo Rat	*Meadow Mouse*		
		Meadow Mouse			
		Harvest Mouse			
June 29		Pocket Gopher	*Bird*	#8	June 30
		Meadow Mouse	*Meadow Mouse*		
June 30		Pocket Gopher			
		Kangaroo Rat			
		Meadow Mouse			
July 1		Pocket Gopher	*Meadow Mouse*	#9	July 2
		Pocket Gopher	*Pocket Gopher*		
		Pocket Mouse			
		Kangaroo Rat			
July 2		Meadow Mouse			
July 3		Harvest Mouse	*Pocket Gopher*	#10	July 4
		Pocket Mouse	*Meadow Mouse*		
		Kangaroo Rat			
		Meadow Mouse			
July 4		Meadow Mouse	*Pocket Gopher*	#11	July 5
		Meadow Mouse	*Meadow Mouse*		
		Kangaroo Rat			
		Kangaroo Rat			
		Pocket Mouse			
July 5		Meadow Mouse	*Meadow Mouse*	#12	July 6
		Pocket Gopher	*Meadow Mouse*		
		Kangaroo Rat	*Pocket Gopher*		
		White-footed Mouse	*Kangaroo Rat*		
July 6		Pocket Gopher	*Pocket Gopher*	#13	July 7
		Meadow Mouse	*Meadow Mouse*		

TABLE 8—Continued

SWAINSON'S HAWK

COMPLETE LIST OF FOODS EATEN COMPARED WITH FOODS IDENTIFIED IN PELLETS

FOODS EATEN			FOODS IDENTIFIED IN PELLETS		
Date	Notes	Items	Items	Pellet No.	Date
July 7		Red-winged Blackbird	*Red-winged Blackbird*	#14	July
		Mole	*Mole*		
		Meadow Mouse	*Small Rodent*		
			Red-winged Blackbird	#15	July 8
			Mole		
July 8		Red-winged Blackbird	*Red-winged Blackbird*	#16	July 9
		Kangaroo Rat	*Kangaroo Rat*		
		Harvest Mouse	*White-footed Mouse?*		
			Pocket Mouse		
July 9		Meadow Mouse	*Meadow Mouse*	#17	July 10
		Pocket Mouse	*Passerine Bird*		
	immature	House Finch			
July 10		Pocket Gopher	*Pocket Gopher*	#18	July 11
		Mourning Dove	*Dove*		
		Kangaroo Rat	*Kangaroo Rat*		
		White-footed Mouse			
July 11	immature	House Finch	*Bird*	#19	July 12
		Meadow Mouse	*Pocket Mouse*		
		Pocket Mouse	*Rodent (Crictine?)*		
		White-footed Mouse			
July 12		Pocket Gopher	*Rodent (Murid?)*	#20	July 13
		Pocket Mouse	*Passerine Bird*		
		House Finch			

TABLE 9
SUMMARY: FOODS FED TO BARN OWL
Compared With
ITEMS RECOVERED FROM PELLETS

Items	Fed to owl		Found in owl pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
Mole	1	1.8	1	2.0
Kangaroo rat	5	8.9	7	14.0
Pocket gopher	8	14.3	9	18.0
White-footed mouse	6	10.7	6	12.0
Meadow mouse	2	3.6	2	4.0
Domestic rat	1	1.8	1	2.0
ALL RODENTS (Subtotal)	(23)	(41.1)	(26)	(52.0)
Goldfinch	5	8.9	5	10.0
House finch	2	3.6	1	2.0
Crowned sparrow	1	1.8	--	----
Spotted towhee	3	5.3	--	----
Junco	1	1.8	--	----
Blackbird	2	3.6	2	4.0
Brown Towhee	1	1.8	1	2.0
Small Fringillid	--	----	1	2.0
ALL PASSERINES (Subtotal)	(15)	(26.8)	(10)	(20.0)
Valley quail	12	21.4	7	14.0
Chicken (bantam)	1	1.8	--	----
ALL GALLINACEOUS (Subtotal)	(13)	(23.2)	(7)	(14.0)
Mourning dove	5	8.9	2	4.0
Unidentified birds	--	----	5	10.0
ALL BIRDS (Subtotal)	(33)	(58.9)	(24)	(48.0)
TOTAL ALL ITEMS	56	100.0	50	100.0

TABLE 10

SUMMARY: FOODS FED TO PACIFIC HORNED OWL

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to owl		Found in owl pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
Ground squirrel	3	4.0	6	8.7
Cottontail or brush rabbit	2	2.7	1	1.4
House mouse	10	13.3	5	7.2
White-footed mouse	7	9.3	2	2.9
Wood rat	1	1.3	1	1.4
Meadow mouse	5	6.7	6	8.7
Kangaroo rat	4	5.3	3	4.3
Pocket gopher	4	5.3	5	7.2
Unidentified rodent	--	----	1	1.4
ALL RODENTS (Subtotal)	(36)	(48.0)	(30)	(43.5)
House finch	14	18.7	3	4.3
Kingbird	1	1.3	1	1.4
Shrike	1	1.3	2	2.9
Meadow lark	2	2.7	3	4.3
Blackbird	16	21.3	15	21.7
Thrasher	1	1.3	1	1.4
Brown towhee	1	1.3	--	----
Unidentified Passerine	--	----	4	5.8
ALL PASSERINES (Subtotal)	(36)	(48.0)	(29)	(42.0)
Valley quail	1	1.3	2	2.9
Mourning dove	2	2.7	6	8.7
Unidentified bird	--	----	2	2.9
ALL BIRDS (Subtotal)	(39)	(52.0)	(30)	(56.5)
TOTAL ALL ITEMS	75	100.0	69	100.0

TABLE 11

SUMMARY: FOODS FED TO BURROWING OWL

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to owl		Found in owl pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
Ground squirrel	1	9.1	1	14.3
House mouse	1	9.1	1	14.3
ALL RODENTS (Subtotal)	(2)	(18.2)	(2)	(28.6)
House finch	6	54.5	2	28.6
Blackbird	1	9.1	--	----
Meadow lark	1	9.1	--	----
Unidentified Passerine	--	----	2	28.6
ALL PASSERINES (Subtotal)	(8)	(72.7)	(4)	(57.1)
Valley quail	1	9.1	--	----
Unidentified bird	--	----	1	14.3
ALL BIRDS (Subtotal)	(9)	(81.8)	(5)	(71.4)
TOTAL ALL ITEMS	11	100.0	7	100.0

TABLE 12
SUMMARY: FOODS FED TO MARSH HAWK
Compared With
ITEMS RECOVERED FROM PELLETS

Items	Fed to hawk		Found in hawk pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
House mouse	8	15.7	1	3.7
Domestic rat	5	9.8	4	14.8
White-footed mouse	1	2.0	--	----
Kangaroo rat	3	5.9	--	----
Meadow mouse	4	7.8	4	14.8
Ground squirrel	1	2.0	--	----
Brush rabbit	2	3.9	1	3.7
Pocket mouse	1	2.0	1	3.7
Pocket gopher	1	2.0	1	3.7
Murid rodent	--	----	1	3.7
Unidentified rodent	--	----	2	7.4
ALL RODENTS (Subtotal)	(26)	(51.0)	(15)	(55.6)
Blackbird	8	15.7	2	7.4
House finch	6	11.8	1	3.7
Other Passerines	6	11.8	--	----
Unidentified Passerines	--	----	7	25.9
ALL PASSERINES (Subtotal)	(20)	(39.2)	(10)	(37.0)
Valley quail	2	3.9	--	----
Mourning dove	3	5.9	--	----
Unidentified bird	--	----	2	7.4
ALL BIRDS (Subtotal)	(25)	(49.0)	(12)	(44.4)
TOTAL ALL ITEMS	51	100.0	27	100.0

TABLE 13

SUMMARY: FOODS FED TO COOPER'S HAWK

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to hawk		Found in hawk pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
House mouse	10	20.8	5	14.7
Domestic rat	3	6.2	1	2.9
Pocket gopher	2	4.2	2	5.9
Ground squirrel	1	2.1	3	8.8
Meadow mouse	1	2.1	1	2.9
Kangaroo rat	3	6.2	3	8.8
White-footed mouse	3	6.2	4	11.8
Harvest mouse	1	2.1	1	2.9
Unidentified rodent	--	----	1	2.9
ALL RODENTS (Subtotal)	(24)	(50.0)	(21)	(61.8)
Valley quail	1	2.1	--	----
Mourning dove	3	6.2	1	2.9
Blackbirds	12	25.0	2	5.9
House finch	4	8.3	1	2.9
Other Passerines	4	8.3	4	11.8
ALL PASSERINES (Subtotal)	(20)	(41.7)	(7)	(20.6)
Unidentified bird	--	----	5	14.7
ALL BIRDS (Subtotal)	(24)	(50.0)	(13)	(38.2)
TOTAL ALL ITEMS	48	100.0	34	100.0

TABLE 14

SUMMARY: FOODS FED TO PRAIRIE FALCON

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to hawk		Found in hawk pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
Brush rabbit	1	1.4	--	----
Ground squirrel	1	1.4	--	----
Kangaroo rat	6	8.2	3	8.3
White-footed mouse	9	12.3	2	5.6
Meadow mouse	10	13.7	8	22.2
Harvest mouse	9	12.3	2	5.6
Pocket gopher	3	4.1	2	5.6
Pocket mouse	3	4.1	1	2.7
Cricetine rodent	--	----	1	2.7
ALL RODENTS (Subtotal)	(42)	(57.5)	(19)	(52.7)
House finch	8	10.9	2	5.6
Blackbird	11	15.1	7	19.4
Other Passerines	8	10.9	--	----
Unidentified Passerines	--	----	8	22.2
ALL PASSERINES (Subtotal)	(27)	(37.0)	(17)	(47.2)
Valley quail	3	4.1	--	----
Mourning dove	1	1.4	--	----
ALL BIRDS (Subtotal)	(31)	(42.5)	(17)	(47.2)
TOTAL ALL ITEMS	56	100.0	36	100.0

TABLE 15

SUMMARY: FOODS FED TO RED-TAILED HAWK

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to hawk		Found in hawk pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
House mouse	1	1.4	2	5.9
Ground squirrel	1	1.4	--	----
Pocket gopher	9	12.9	4	11.8
Domestic rat	2	2.9	1	2.9
Meadow mouse	6	8.6	6	17.6
Brush rabbit	1	1.4	2	5.9
Kangaroo rat	6	8.6	2	5.9
White-footed mouse	2	2.9	--	----
Pocket mouse	1	1.4	--	----
Wood rat	1	1.4	--	----
Unidentified rodent	--	----	2	5.9
ALL RODENTS (Subtotal)	(30)	(42.9)	(19)	(55.9)
House finch	7	10.0	--	----
Blackbird	23	32.8	5	14.7
Brown towhee	3	4.3	--	----
Other Passerines	4	5.7	7	20.6
ALL PASSERINES (Subtotal)	(37)	(52.8)	(12)	(35.3)
Valley quail	3	4.3	1	2.9
Unidentified birds	--	----	2	5.9
ALL BIRDS (Subtotal)	(40)	(57.1)	(15)	(44.1)
TOTAL ALL ITEMS	70	100.0	34	100.0

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TABLE 16

SUMMARY: FOODS FED TO SWAINSON'S HAWK

Compared With

ITEMS RECOVERED FROM PELLETS

Items	Fed to hawk		Found in hawk pellets	
	Number	Per cent of total fed	Number	Per cent of total identified
Domestic rat	1	1.4	1	2.4
White-footed mouse	4	5.5	1	2.4
Kangaroo rat	9	12.5	3	7.3
Meadow mouse	12	16.6	9	21.9
Harvest mouse	3	4.2	--	----
Pocket gopher	8	11.1	6	14.6
Pocket mouse	6	8.3	2	4.9
Mole	1	1.4	2	4.9
Cricetine rodent	--	----	1	2.4
Murid rodent	--	----	1	2.4
Unidentified rodent	--	----	1	2.4
ALL RODENTS (Subtotal)	(44)	(61.1)	(27)	(65.8)
House finch	4	5.5	--	----
Blackbird	12	16.6	7	17.1
Other Passerines	8	11.1	--	----
Unidentified Passerines	--	----	2	4.9
ALL PASSERINES (Subtotal)	(24)	(33.3)	(9)	(21.9)
Valley quail	2	2.8	--	----
Mourning dove	2	2.8	1	2.4
Unidentified birds	--	----	4	9.8
ALL BIRDS (Subtotal)	(28)	(38.9)	(14)	(34.1)
TOTAL ALL ITEMS	72	100.0	41	100.0

FOOD HABITS OF NESTING BARN OWLS AND MARSH HAWKS AT DUNE LAKES, CALIFORNIA, AS DETERMINED BY THE "CAGE NEST" METHOD

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Many facts regarding the food habits of barn owls and marsh hawks are known. Much of this information, however, is general in character and cannot be applied to specific areas. This investigation was designed to determine the food habits of these two raptors on an area characterized by an extremely heavy valley quail population.

This present study is a part of a general investigation into the management of valley quail at the Dune Lakes Club in San Luis Obispo County, California.[2] Over a period of years, the owners of this club have been successful in increasing the numbers of quail to such a degree that just prior to the hunting season of 1941, a population of about 5 birds per acre existed. In the shooting season of 1941, 598 quail were taken in the hunters' bags from an area not exceeding 400 acres in size, leaving no readily appreciable decrease in numbers.

It seemed to us that it was possible for raptors usually regarded as beneficial, or at least not particularly harmful, to avail themselves of this enormous population of valley quail and change their food habits to include this abnormally abundant species. The discovery by the senior author of a technique for determining the food habits of certain nesting raptors enabled us to gain much valuable information on the foods of barn owls and marsh hawks on the Dune Lakes Club. This technique is described herein, and data are presented concerning the foods brought to several barn owl and marsh hawk nests during the seasons of 1941 and 1942 at locations on and near the Dune Lakes Club.

Methods

Search for nests began as early as February and continued through May each year. Barn owl nests found were all located in artificial situations such as duck blinds and an abandoned skeet tower. The marsh hawk nests were in tule and other vegetation in marshy places on and near the Dune Lakes Club. The nests were observed periodically for hatching and development of the nestlings. The young raptors were left undisturbed until they were fully feathered and just about ready to leave the nests. In fact, in the case of one marsh hawk nest, it was

[1] Submitted for publication, April, 1943.

[2] Federal Aid in Wildlife Restoration, Project California 6-R, The Management of California Valley Quail in the South Coast Counties of California.

Grateful acknowledgment is hereby extended to the members of Dune Lakes, Ltd., for allowing us to conduct this study on their property and for cooperating in the conduct of the general quail management studies.

necessary to pursue the young harriers for some distance from the nest in order to capture them for enclosure in the "cage nest."

After the raptors had attained their full juvenile plumage, they were placed in chicken wire pens that were simply placed over their nests (Figs. 31 and 32). These pens varied from a circular, covered enclosure about 2½′ in diameter and 1′ high, to a larger pen made from an old quail trap. The size of the pens varied with the number of young in the particular nest. Doors large enough to insert food were made in the cages.

In general, the rest of the procedure depended on the adult hawks or owls. The parent barn owls cooperated very well in that, almost without exception, they piled their nightly offerings to their young neatly beside the "cage nest." All that remained to be done was to

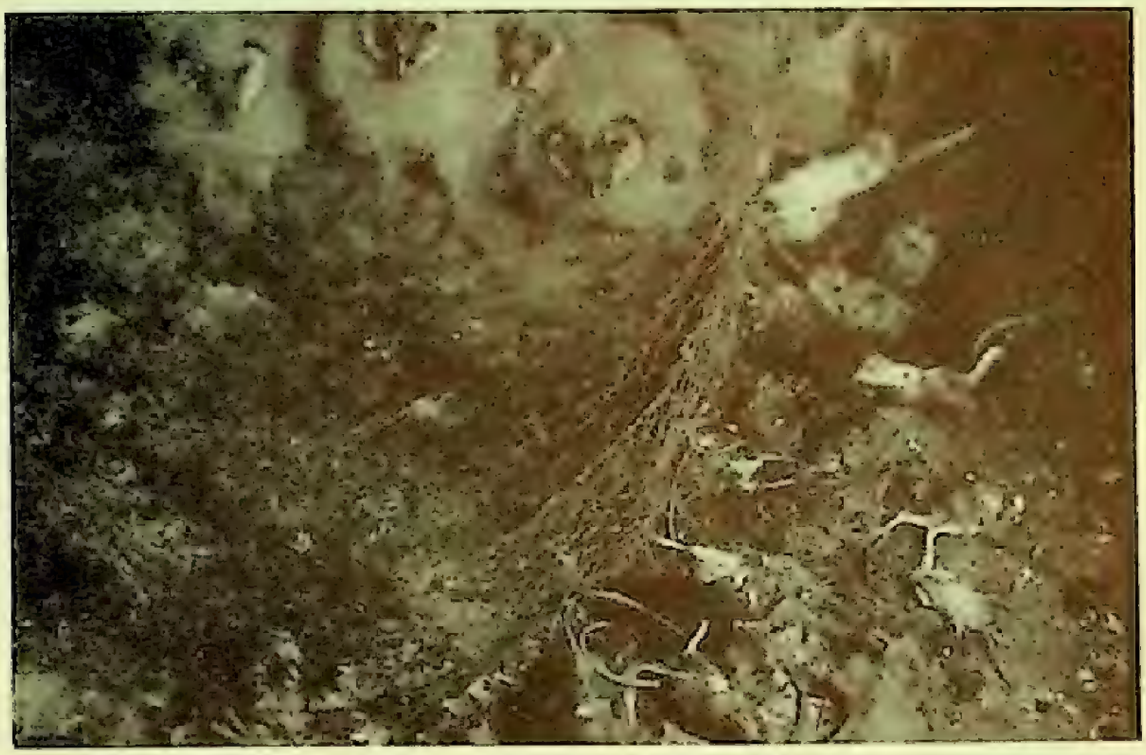

FIG. 31. Barn owl cage nest No. 6, 1942. Note prey items piled beside cage nest exactly as left by the adult owls.

visit the nests early each morning, record the items found according to numbers and species, and feed the nestlings.

The marsh hawks, however, were not quite so obliging and it required a little study of their habits of foraging and feeding nestlings before a way was found to induce their cooperation. It was found from observation that the male hawk did most of the foraging and would bring food items to the vicinity of the nest, where he would pass the prey to the female in mid-air. The female would then feed the young, often taking a choice portion for herself. It was found that if the young were merely caged, as in the case of the barn owl, the female would attempt to feed the young and not meeting with success, would often take the item away to a nearby roost, eat part of it, and discard the rest. We tried in one instance (marsh hawk nest No. 1, 1942) to pen the adult female in a separate enclosure near the young hawk's cage nest, but her cries evidently discouraged the male from approaching the nest with the

prey. It was found that if the female was removed from the scene several days after the young were caged, the male would redouble his efforts to keep the brood well fed and readily leave items at the nest. This procedure was followed in studying the three 1942 marsh hawk nests.

Visits to the marsh hawk nests were made late in the afternoon. Prey items found were listed and then fed to the young through the cage door as in the case of the barn owl.

During the summer of 1942, a variety of raptor foods was required for another study (Glading, Tillotson and Selleck, 1943). Accordingly, we "traded" the items we found at the trap nests for house mice and ground squirrels that we could easily obtain.

FIG. 32. Marsh hawk cage nest No. 2, 1942. The prey beside the cage was placed there by the adult male marsh hawk.

Results

Table 1 is a complete daily list of foods brought to barn owl nest No. 6, 1942, located at the abandoned skeet tower in the center of quail population at the Dune Lakes Club. Similar lists were compiled for all nests under observation, but lack of space precludes their presentation here. A summary of all items brought to all barn owl cage nests during the two seasons' study will be found in Table 2. The most apparent difference between the various nests was that relatively more marsh-frequenting birds (swallows, tule wrens, and rails) were brought to the nests located in duck blinds in the marshes than were brought to nest No. 6, 1942, which was in an upland situation. The only quail listed were brought to this skeet tower site. The lists of rodent prey were fairly similar in both marsh and upland nests.

It will be noted from a study of Table 1, that the number of items brought to nest No. 6 varied from 1 to 24 nightly. The average number per night was 8.0. The favorite foods were pocket gophers

and meadow mice, which were found at the nest almost every morning. Birds made up a relatively small proportion (6.4 per cent) of the total bulk brought to nest No. 6 and to all other nests as well. The percentage of birds was about the same as that found in a series of pellets taken from this same skeet tower before the installation of the trap nest. This previous pellet analysis, completed by Mr. Elmer Aldrich, revealed 6.7 per cent of birds among the 335 individual items identified in the debris found in the skeet tower during the spring of 1941.

Table 2, the two-year summary of all barn owl prey, shows that preferred nesting-season foods were pocket gophers, meadow mice, and kangaroo rats. The percentage of game birds taken was extremely small. The two valley quail taken were young birds.

Table 3 presents a daily list of all items brought to marsh hawk nest No. 2, 1942, located about 200 yards east of the Dune Lakes boundary. The principal foods were house finches, blackbirds, valley quail, and brush rabbits. The average daily catch (excluding the three days during which the female was still present) was 8.5, varying from 1 to 19 per day. Most of the nongame birds taken were nestlings or newly fledged, while *all* of the quail were under twelve weeks of age. Since rather wide differences were evident in types of foods brought to the various marsh hawk nests studied, a nest by nest summary is presented in Table 4.

Marsh hawk nests were located in areas of different quail population intensities. This was reflected in the variation in percentages of quail taken. At the nests in the Celery Lake marsh (No. 1, 1941 and No. 1, 1942), 21.9 per cent of all items brought in were young valley quail. At nest No. 2, 1942, located about 200 yards east of the club boundary, 11.7 per cent of the prey were quail, while at nest No. 4, 1942, two miles east of the club in Black Lake Slough, only 5.6 per cent valley quail were among the items noted.

It will be noted that the very high percentage of quail brought to the two marsh hawk nests in Celery Lake marsh is greater than any total percentage of game birds reported in other series of marsh hawk food habits studies (Bent, 1937).

Without exception all of the valley quail brought to the marsh hawk nests were young birds under 12 weeks of age. Almost all of the doves recorded were also young. In the case of the large numbers of blackbirds reported at nests No. 3 and No. 4, both young and adult birds were taken, but the majority were nestlings. In the case of nest No. 4, 1942, as many as 11 blackbird nestlings were brought in during one day.

TABLE 1

DAILY LIST OF ITEMS BROUGHT TO BARN OWL CAGE NEST 26, 1942, DUNE LAKES CLUB (6 YOUNG BARN OWLS IN NEST)*

SPECIES	MAY	JUNE									JULY																										Total	Per cent of diet
	25	13	17	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27		
Brush rabbit		1						1															1				1										4	1.1
Kangaroo rat					2		8	1		2	1		1	1	5		1	1		11	1			3	1		4	2	7		2	3	1					58	15.5
Pocket mouse							3			1	1		3	1			1		3	3	2	1		1		1									1			22	5.9
Pocket gopher	14	3	1		7	5	3		2	2	3	5	5	2	4	2	3	5	6	6	6	5	2	4	2	2		2	1	1			1	2				106	28.7
Meadow mouse	1	1			2	2	6	3	2	4	5	3	5	4	5	2	3	5	3	2	3	3	2	1	3	2	3	3	3	3	1	4	4	2		3	5	103	27.6
White-footed mouse					1	1	1	3					1	1	2			1	1	1	2			1		2	2	3				2	2					27	7.2
Harvest mouse							1	1	1		1		2	1	1		1	3		1				2					1	1								17	4.5
House mouse				1												1																						2	.5
Domestic rat																								2			1	1			1							5	1.3
Wood rat	1																					1			1											2		5	1.3
Mole																	1																					1	.3
Subtotal mammals																																						(350)	(93.6)
Valley quail							1					1																										2	.5
Virginia rail																									1						1							2	.5
Blackbird											1		1					2	1			2				3		3	1		1							15	4.0
Bullock oriole																										1												1	.3
Brown towhee															1						1																	2	.5
Spotted towhee						1																																1	.3
House finch								1																														1	.3
Subtotal birds																																						(24)	(6.4)
Daily total	16	5	1	1	12	9	23	10	5	9	12	9	18	10	18	5	10	17	14	24	15	12	5	14	8	11	11	14	13	5	6	9	8	4	1	3	7	374	100.0

* Observations prior to June 25 are of fragments of prey items. Young owls were penned on June 24, hence all data on and after June 25 are cage nest records.

TABLE 2

SUMMARY OF FOOD ITEMS BROUGHT TO 6 BARN OWL CAGE NESTS, DUNE LAKES CLUB, 1941, 1942

Nest No.	Situation of nest	Number of young owls in nest	Number of days observed	Brush rabbit	Kangaroo rat	Pocket mouse	Pocket gopher	Meadow mouse	White-footed mouse	Harvest mouse	House mouse	Domestic rat	Wood rat	Muskrat	Mole	Opossum	Subtotal mammals	Valley quail	Virginia rail	Unidentified shore bird	Blackbird	Meadow lark	Bullock oriole	Brown towhee	Spotted towhee	House finch	Tule wren	Swallow	Unidentified passerine	Subtotal birds	Total items per nest
#3, 1941	Marshy	4	49	9	24		101	36	6	2		3		1	2				1		3					1	2	1	4		196
#1, 1942	Upland	4	4	8	0		3	5	2																			7			27
#2, 1942	Marshy	4	30	12	23	1	66	51	10	2		1		2					2	1	2	1				1	1	15	1		192
#4, 1942	Marshy	1	28	15	4	1	41	3	1					1	1				1									7			75
#5, 1942	Marshy	4	23	11	0	3	36	4	2			1	1			1			1		2							1			69
#6, 1942	Upland	6	47	4	58	22	106	103	27	17	2	5	5		1			2	2		15		1	2	1	1					374
Species total		23	181	59	124	27	353	202	48	21	2	10	6	4	4	1	(861)	2	7	1	22	1	1	2	1	3	3	24	5	(72)	933
Per cent of diet				6.3	13.3	2.9	37.8	21.7	5.1	2.3	.2	1.1	.6	.4	.4	.1	(92.3)	.2	.8	.1	2.4	.1	.1	.2	.1	.3	.3	2.6	.5	(7.7)	100.0

TABLE 3

DAILY LIST OF ITEMS BROUGHT TO MARSH HAWK CAGE NEST # 2, 1942, NEAR DUNE LAKES CLUB (4 YOUNG MARSH HAWKS IN NEST)*

SPECIES	May	June																						Total	Per cent of diet
	27	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26		
Brush rabbit						1	1	3	6	2	1	2	4	3		1								24	14.0
Kangaroo rat							1														1			2	1.2
Meadow mouse	1					1	1			1	1		1	3		1	1		2			1		14	8.2
Pocket gopher							1																	1	.6
Subtotal mammals																								(41)	(24.0)
Valley quail						3		2		4	1	4				1	1	2	1	1				20	11.7
Dove									1							1								2	1.2
Woodpecker												1												1	.6
Killdeer																					1			1	.6
House finch						12	7						1			2	5	1	3		1			32	18.7
Goldfinch							3			2	2	2				1			1		2			13	7.6
Brown towhee	2								1		1	2						1						7	4.1
Spotted towhee															2									2	1.2
Crowned sparrow													3											3	1.8
Lark sparrow																					1		1	2	1.2
Tule wren							1			1		1												3	1.8
Bushtit										2		1												3	1.8
California thrasher									2			1												3	1.8

Blackbird						1		4		2		2		1	5			1		3		2		21	12.3
Unidentified Passerines					1	1	1	5	1	2		1		2			1						15	8.8
Subtotal birds																							(128)	(74.8)
Fence lizard											1												1	.6
Horned toad								1															1	.6
Subtotal reptiles																							(2)	(1.2)
Daily total	3	0	0	0	1	19	16	15	11	16	7	17	9	9	7	7	8	5	7	4	6	3	1	171	100.0

*May 27 observation is of food fragments found at nest. Young birds were placed in cage nest on June 4. Adult female was shot on June 8.

TABLE 4

SUMMARY OF FOOD ITEMS BROUGHT TO 4 MARSH HAWK CAGE NESTS, DUNE LAKES CLUB, 1941, 1942

Nest #	Location	No. of hawks in nest	No. of days observed	Jack rabbit	Brush rabbit	Kangaroo rat	Meadow mouse	Pocket gopher	Mole	Subtotal mammals	Valley quail	Dove	Rail	Woodpecker	Killdeer	House Finch	Goldfinch	Brown Towhee	Spotted Towhee	Crowned sparrow	Lark sparrow	Tule wren	Bush-tit	Wren-tit	California thrasher	Blackbird	Bullock oriole	Meadow lark	Unidentified Passerine (Mostly sparrows)	Subtotal birds	Fence lizard	Horned toad	Subtotal reptiles	Total items per nest
#1, 1941	Celery Lake, Dune Lakes Club	3	16		15		9				20	1	2			2						1	1	2		6			26				85
#1, 1942	Celery Lake, Dune Lakes Club	2	10		6	2					3																		5		4			20
	Subtotal Celery Lake Nests	(5)	(26)		(21)	(2)	(9)				(23)	(1)	(2)			(2)						(1)	(1)	(2)		(6)			(31)		(4)			(105)
#2, 1942	200 yards east, Dune Lakes Club	4	20		24	2	14	1			20	2		1	1	32	13	7	2	3	2	3	3		3	21			15		1	1		171
#4, 1942	2 miles east, Dune Lakes Club	3	21	1	4				1		9	11				10	4	2	2		1		2		2	73	1	14	35					162
	Species total	12	67	1	49	4	23	1	1	(79)	52	14	2	1	1	44	17	9	4	3	3	4	6	2	5	100	1	14	71	(353)	5	1	(6)	438
	Per cent of diet			.2	11.2	.9	5.3	.2	.2	(18.0)	11.9	3.2	.5	.2	.2	10.0	3.9	2.1	.9	.7	.7	.9	1.4	.5	1.1	22.8	.2	3.2	16.2	(80.6)	1.1	.2	(1.4)	100.0

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Discussion

Tables 1 and 2 indicate that barn owl foods include a high percentage of rodents during the critical nesting season at a location where valley quail are abnormally plentiful. The percentage of birds taken during the nesting season is practically the same as the percentage observed in a series of pellets from one of the same nesting sites. This is corroborative evidence that barn owl pellets are a good indicator of the food habits of this raptor (Glading, Tillotson and Selleck, 1943).

Some objection might be raised to the present type of food habits study in that we have upset natural conditions by penning the young. We feel that while this might possibly affect the volume of food brought into the nest by either increasing or decreasing it, still it should not affect the owl's capabilities of catching different types of prey. It is possible that the adult owls might be frightened by artificial structures about the nests and thus tend not to bring as many items as they would otherwise. On the other hand, the young owls, not being able to get to the food that is left beside the pen, might raise a hunger cry that would tend to intensify the hunting effort of the adults. Therefore, too much credence cannot be placed either on daily total of items brought to the nest or on the total for any one particular nest. However, the relative proportion of the various items left at the cage nest would seem to be indicative of the owl's total ability.

Our studies of the barn owl cage nest are sufficient proof to us that this raptor is a desirable species to have on a quail management area. The almost infinitesimal percentage of game birds taken is so very greatly over-balanced by the large numbers of competitor and predator rodents that the presence of barn owls on a quail area is certainly to be desired.

A study of foods brought to marsh hawk nests, on the other hand, reveals that these raptors take considerable quantities of young valley quail when such are available. This is born out in our comparison of marsh hawk nests located on areas of heavy, medium, and low quail concentrations. The fact that 21.9 per cent of all items brought into the nests in the center of quail populations are quail indicates that there is no place for the marsh hawk on a quail nesting territory. In addition to the large numbers of quail taken, it will be noted that a large proportion of the balance of the diet is composed of birds that are of little or no importance as competitors to the quail and that the percentage of rodents taken is small. Another game species, brush rabbit, formed 11.2 per cent of the food brought to these nests.

Summary

A new method for studying the food habits of nesting barn owls and marsh hawks is herein presented. By this method, studies were made of the foods brought to six barn owl nests and four marsh hawk nests at the Dune Lakes Club in 1941 and 1942. Barn owls on this area of high valley quail concentration did not take appreciable numbers of quail or other birds. Marsh hawks, on the other hand, took a relatively high percentage of quail, as much as 23.5 per cent of all items in the case of one nest.

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FIG. 33. A typical pool in the Central Valleys in need of fish rescue. Near Patterson, California.

Photo by Leo Shaporalov

FIG. 34. A typical pool in the Coastal Area in need of rescue work. The pool was the location of the mouth of a temporary stream. Near Garberville, on the Eel River, California.

FISH RESCUE IN CALIFORNIA [1]

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Fish rescue has become of increasing interest in California because it affords a means of conservation through the transplanting of stranded fish into safe waters. During the past six years the State Division of Fish and Game has salvaged over eight million fish annually. This work is necessitated by the geographical and meteorological conditions in two large areas in the state, the coastal region and the central valleys.

Along the coast the streams flow through low rolling mountains. Due to the normal absence of summer rains, many streams that support runs of spawning salmon and steelhead trout during the winter and spring dry up in summer into a series of pools that become uninhabitable for the young fish.

In the central valleys, the run-off from the Sierra Nevada snow pack floods the already saturated ground during May, June and July. Many warm-water fishes seek out the shallows to spawn during this period, and thus become spread over enormous areas, sometimes miles away from the natural stream beds. When the waters recede, thousands of fish may be stranded in small pools or temporary ponds which, in the summer heat, turn into stagnant holes. Here the fish are trapped, unable to return to fresh water, beset by predatory birds, and vulnerable to disease, so that even if the pools do not dry up completely, great losses occur. There may also be local migrations into the inundated areas by young fish seeking better forage, for newly flooded lands are often producers of abundant plankton—the food of fry and young fingerlings. Thus the entire central portion of the state—the Sacramento-San Joaquin Valley—becomes a field of spiny-rayed fish rescue operations.[2] The season usually extends from June through October, although occasional work may be necessary at any time during the year.

To provide for efficient fish rescue operations the Bureau of Fish Conservation has inaugurated a systematic procedure for the work. Rescue districts have been designated in southern California, the coastal area, and the central valleys. A seasonal supervisor and his crew generally return to the same district year after year. The rescued fish are distributed as best indicated by stream surveys. The present scheme has shown gratifying results in the way of operating efficiency, and of improved angling in many of the regions where intensive work has been carried on for a period of years.

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[1] Submitted for publication, January, 1943.

[2] The term "spiny-rayed fish" as used in California includes all the warm water sport fishes, i.e., black basses, crappies, sunfishes and catfishes, as distinguished from the salmonoids.

History

Fish rescue has been employed as a conservation measure by the Division of Fish and Game since about 1904. At first its principal function was to extend the range of the spiny-rayed fishes, all of which, with the exception of the Sacramento Perch, are aliens to this state. A great many were imported from east of the Mississippi during the period 1871-1908, but it was manifestly impractical to transport enough across the continent to stock all our suitable waters. Early "fish rescue" therefore, utilized the localities in which these fishes were first

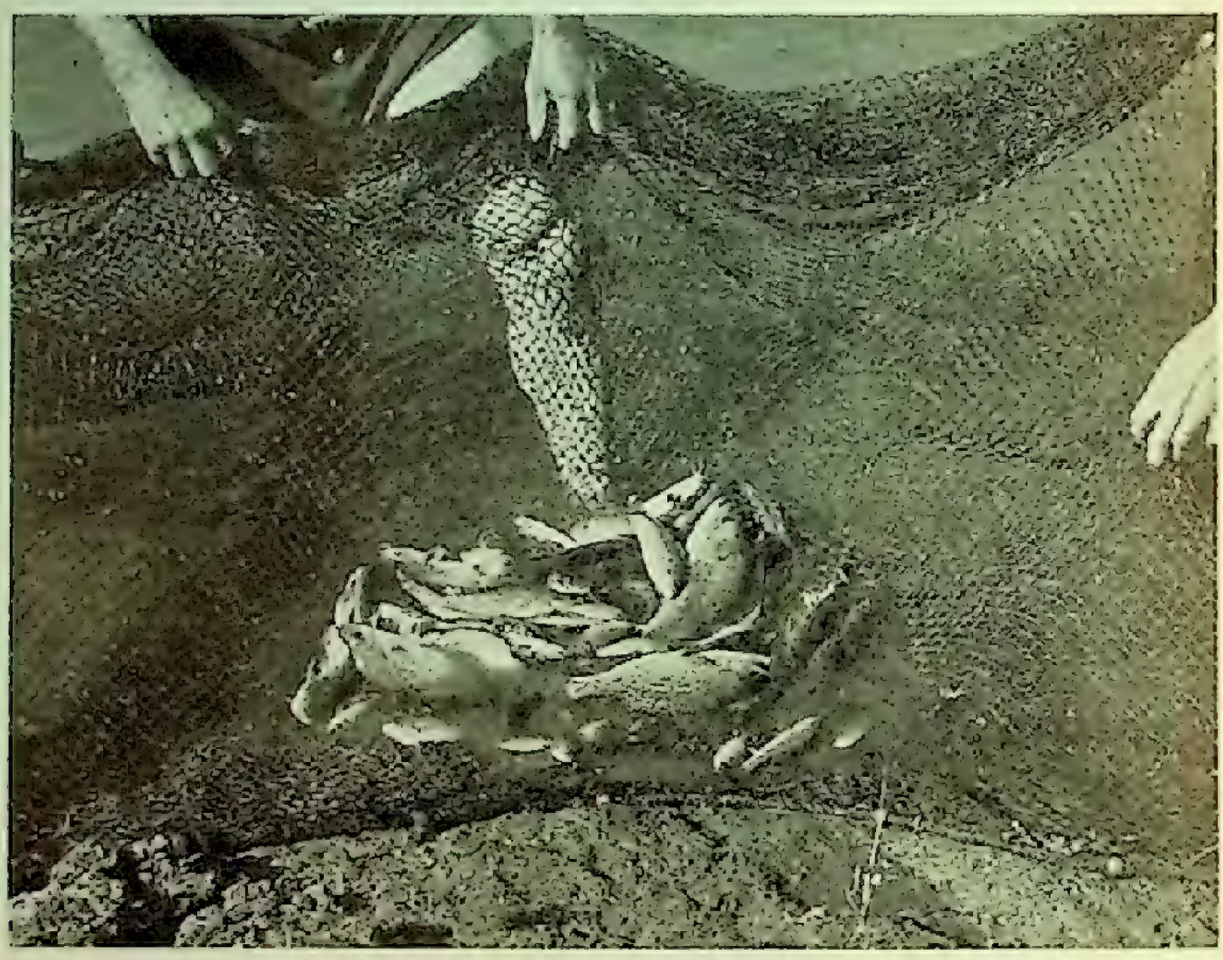

FIG. 35. A small group of representative fishes rescued in the Central Valleys.

placed as natural hatcheries, sources from which to redistribute them into unstocked waters. The records indicate that 507 lots of rescued fish were transplanted by the state in this way between 1904 and 1912.

As the introduced fishes increased in numbers and spread out into regions subject to inundation and drying, fish salvage began to receive serious thought. From 1913 on, fish rescue became a method of increasing the productivity of streams and lakes by returning fish directly to the same waters from which they had strayed during the floods, and transplantation became a secondary consideration. The early work was carried on largely by fish and game wardens and interested citizens who were called upon for assistance. By 1928 fish rescue had become so important that Mr. George Neale, a pioneer in the work, was placed in charge of all such operations throughout the state, and continued in

this capacity until his retirement in 1934, at which time the Bureau of Fish Conservation took over. Central valleys rescue is now under the direction of the foreman of the state bass hatchery located near Sacramento. Trout rescue is usually directed by the foreman of the trout hatchery nearest to the scene of operations.

The number of fish rescued declined somewhat from 1934 to 1936, but has increased sharply since then as shown in Table 1. Tables 1 and 2 give figures only from 1936 on as a new system of fish rescue work has become state-wide since that date. It should be noted that Table 2 is not a true picture of the relative abundance of each species

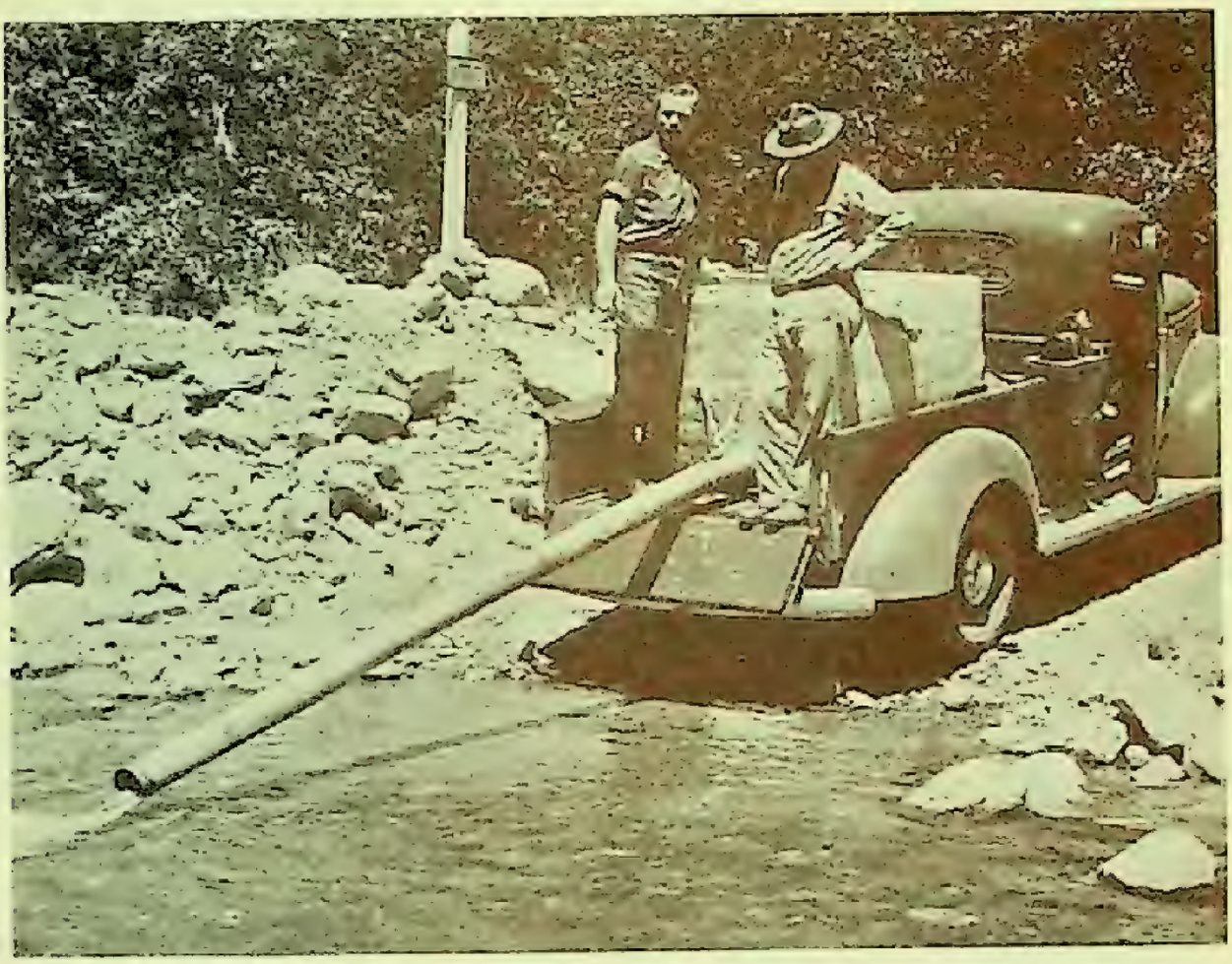

FIG. 36. Planting rescued fish from a pickup truck equipped with a 250-gallon fish tank. The aerating pump unit is located forward on the upper right part of the truck bed. This entire fish planting unit was suggested and built by members of the California Bureau of Fish Conservation.

in California as it is a result of selective rather than of random sampling. Most of the rescue work is done in the large central valleys portion of the state containing only warm, sluggish waters meandering through broad plains. Therefore, fish from this type of water—Large-mouthed Black Bass, sunfishes, catfishes—are better represented in the table than those from other parts of the state. The mountain creeks and those portions of larger streams flowing through the foothills, while subjected to floods also, lie in restricted valley troughs where rescue is unnecessary, and the fish of those habitats—the Small-mouthed Black Bass, the Spotted Bass, and the trout and young salmon—fail to appear in the lists.

Methods

In California, fish rescue is carried on by two-man units, one or more of such crews operating in a designated area. Each crew is equipped with a pickup truck; burlap covered milk cans or a 250-gallon insulated tank; mechanical aerator and emergency hand aerators; dip nets, buckets, tubs, tools, seines, seine mending kits, and thermometers; also the necessary maps of the district to be worked. Seines range from 10 feet by 3 feet to 100 feet by 8 feet, depending on the work, and in mesh from fine bobbinet to 1 inch stretched measure.

It has been found highly desirable for each supervisor to make a reconnaisance of his area a short time before the season's work begins,

FIG. 37. Completing the seining of a pond. The rescue net is brought in as indicated.

to be supplemented, if possible, by an aerial survey once he has become familiar with his district. These observations permit him to locate new ponds, roads, and routes, and to make notes on such important points as water turbidity (muddy or roily water usually indicates the presence of fish); character of the terrain (pools in light soils will drop rapidly as the water table falls, while those in heavier soils will hold up for some time); routes which will permit the quickest transportation of rescued fish to safe waters; conditions in the particular pools which will determine types of net to use and need of brush clearing or other preliminary work; and sources of pure, cool, fresh water for use in the fish cans or tanks, the water from the stagnant holes from which the fish are rescued being very undesirable, if not dangerous, for this purpose.

Aside from the official fish rescue crews, local wardens are of great help in locating and planting stranded fish and local sportsmen's clubs often give information and lend assistance.

In the actual conduct of fish rescue operations the general object is to secure as many fish as possible without undue waste of time and effort. Choice of the proper net for the work in hand is an important factor in achieving this end; in general, the net must be about 30 per cent longer and deeper than the section of water to be seined. Blocking nets are used in big pools to obviate long hauls or the use of large nets. Special techniques are used to avoid the various kinds of obstacles encountered in the work. Netting in any pool is continued until the

FIG. 38. Rescued fish are impounded in a portion of the net for sorting.

yield per haul falls to the point where the work seeems no longer justified; then that pool is abandoned, to be revisited later for further seining after a drop in the water level has again concentrated the remaining fish.

Once enough fish have been obtained to form a load for the truck, one thought is dominant in the minds of all workers—the *safe* transportation of the fish to *safe* waters. In hot weather the rescue work must be done in the cool of the early morning. Care must be taken not to overload the equipment. Under normal operating conditions, a fifteen-gallon milk can may carry 100 to 250 ounces of spiny-rayed fish, with mechanical aeration and water temperatures of not over 70° Fahrenheit; however, different species and sizes have different requirements. Holding ponds are sometimes available for retention of the fish

until their condition is improved, as rescued fish, due to the conditions under which they have been living, are often in a weakened state; but often they must be transported directly to the water into which they are to be stocked. Care is taken to avoid placing them in localities where their enemies are numerous. Waters free from large fish are given preference, and shelters from predatory fishes and birds are sought. Rough fish, unless definitely undesirable, are rescued and transplanted with the game fish in order to provide forage. Records are kept of the waters from which fish are taken, of those into which they are placed, and of the numbers of fish so handled, the adults being counted by tally, the fingerlings by comparing a counted sample with total displacement or total weight.

FIG. 39. Seining a portion of a long pool by the use of a blocking seine. The foreground net is used as a block, and the working seine will be pulled up to it and will be beached. The operator on the right will work along the block, while the other will only pivot to complete the beaching process.

At the end of each day a very important piece of work is the care of equipment, the cleaning and drying of all nets, metal instruments, etc., as without this attention they quickly go to pieces.

The Future of Fish Rescue

The future of fish rescue work has become unpredictable since the inception of the United States Bureau of Reclamation's Central Valleys Project. No doubt the Shasta Dam on the Sacramento River and the Friant Dam on the San Joaquin will reduce flooding from these streams,

but their tributaries below the dams will probably continue their seasonal inundations and necessitate rescue work.

The great canal systems of the Central Valleys Projects will probably harbor many resident or transient fish. Surely, new fish rescue problems will arise from the draining or flushing of various portions of the system. However, the large lakes formed by the dams may have a beneficial effect on the production of warm water fishes.

The coastal streams may be altered by the increasing number of small diversion dams within the limits of trout and salmon water. These dams will necessitate an increased fish rescue program; they not only divert water, but they produce unnatural conditions in the lower reaches of the streams by reducing water flows, thus increasing fish vulnerability to predators and in some cases increasing the water temperature above the limit of trout tolerance.

New problems will arise, demanding new solutions. Very possibly the yearly total of fish rescued will be somewhat reduced, but the numerical aspect is not the only one. The great numbers of fish handled make fish rescue an important method of controlling fish populations. It is thus an effective tool in the management of the inland "warm water" fisheries which, with the continuing rise in the number of anglers, will become of increasing importance as a source of food and recreation.

TABLE 1

NUMBERS OF FISH RESCUED ANNUALLY, 1936-1941

Species	1936	1937*	1938*	1939	1940	1941	1936-1941
Trout	0	36,273	41,354	686,739	907,280	471,973	2,143,619
Salmon	0	85,707	169,685	108,119	200,248	50,700	614,459
All others	39,238	11,378,736	15,393,455	6,044,174	6,456,983	6,713,264	46,025,850
Totals	39,238	11,500,716	15,604,494	6,839,032	7,564,511	7,235,937	48,783,928

* Abnormally high water flows account for the large numbers of fish in 1937 and 1938.

Turn page for Table 2.

TABLE 2

FISH RESCUED DURING THE 1936-1941 PERIOD, ENUMERATED BY SPECIES

Species		Years rescued	Total number
Common Name	Scientific Name		
Square-tail Catfish	*Ameiurus nebulosus*	1937–1941	16,504,112
Large-mouthed Black Bass	*Huro salmoides*	1936–1941	9,010,602
Green Sunfish	*Lepomis cyanellus*	1937–1941	6,013,333
Bluegill Sunfish	*Lepomis machrochirus*	1936–1941	5,093,917
Fork-tail Catfish	*Ictalurus catus*	1937–1941	4,245,576
Black Crappie*	*Pomoxis nigro-maculatus*	1936–1941	3,756,347
Steelhead Trout	*Salmo gairdnerii* (coastal streams)	1937–1941	2,061,038
Small-mouthed Black Bass	*Micropterus dolomieu*	1936–1941	630,131
Warmouth Bass**	*Chaenobryttus coronarius*	1937–1941	527,325
Silver Salmon	*Oncorhynchus kisutch*	1937–1941	309,367
King Salmon	*Oncorhynchus tschawytscha*	1937–1941	219,385
Sacramento Perch	*Archoplites interruptus*	1937–1941	100,067
Channel Catfish	*Ictalurus lacustris*	1940	40,000
Striped Bass	*Roccus saxatilis*	1937–1941	39,802
Rainbow Trout (other than steelhead)	*Salmo gairdnerii* (inland streams)	1939–1941	35,912
Common Shad	*Alosa sapidissima*	1937–1941	25,821
Eastern Brook Trout	*Salvelinus fontinalis*	1939–1941	4,400
Loch Leven or Brown Trout	*Salmo trutta*	1938–1941	3,774
Cutthroat Trout	*Salmo clarkii*	1938–1941	2,222
White Sturgeon***	*Acipenser transmontanus*	1941	5
Mixed Salmon	*Oncorhynchus* sp	1937	85,707
Mixed Trout	*Salmo* sp and possibly *Salvelinus* sp	1937	36,273
Mixed Game and Rough Fish	? species	1936–1941	29,812
Grand total			48,783,928

Summary:		
Catfish		20,789,688
Sunfish (Bluegill and Green Sunfish, Crappie, Warmouth Bass, and Sacramento Perch)		15,190,980
Black Bass		9,649,733
Trout		2,143,619
Salmon		614,459
Striped Bass		39,802
Miscellaneous		55,638
Grand total		48,783,928

* Apparently the range of the White Crappie *Pomoxis annularis* is limited to the Colorado River district, where very little fish rescue is done.

** May include a very few Rock Bass *Ambloplites rupestris*.

*** May include the Green Sturgeon *Acipenser acutirostris*.

ANATOMICAL DIFFERENCES BETWEEN THE RING-NECKED PHEASANT AND THE DOMESTIC CHICKEN AS AN AID IN LAW ENFORCEMENT[1]

By JOHN LAUGHLIN
Bureau of Game Conservation
California Division of Fish and Game

The ring-necked pheasant is by far the most eagerly hunted of the upland game birds in California. It is large, plump and tasty, and quite abundant in many parts of the state. It finds its optimum in agricultural areas rather than in waste brushlands, and is therefore most plentiful in regions frequented by the migrant worker and the lower class farm hand. The consequence is that the ring-neck forms the illegal piéce de resistance of many a meal of these needy humans. However, farm labor is not alone in breaking laws pertaining to pheasants. City hunters, honest enough perhaps in original intent, can not always resist the temptation afforded by a "chink" which explodes underfoot, especially if the doves are not flying, or if the quail or rabbits have been few that day. The hunter goes out for legal shooting, but if there is a dearth of game, some forbidden meat is not beyond acceptance.

If the warden comes upon the violator in the field with the pheasant in his possession there should be little difficulty in identifying the bird, especially if the head or feathers are still in place. Unfortunately, many pheasants reach home with the violator and are cleaned, dressed and the head and feathers destroyed. Then, through information supplied from divers sources, the warden learns that Joe Doakes has killed a pheasant. The warden goes to the local justice of the peace for a warrant, and searches the Doakes' house. No, there is no pheasant there, but he does find a "chicken," according to Doakes, either on the stove stewing, or in the oven. Doakes swears that it is a chicken. The warden's tip-off (which is probably anonymous), says Doakes killed a pheasant. As the bird is cooked, it has lost its distinguishing features: Should Doakes be arrested on the chance that the tip-off was correct, and that he can be bluffed into an admission that the bird is a pheasant? Or should he be released due to uncertainty as to the bird's identity, thereby losing future cooperation of the informant? The possession of irrefutable evidence to support the warden's position, both at the time of making the arrest and in court, would add to the official prestige of the state's employee.

Relationship of Pheasant and Chicken

All living things are systematically classified according to structure into groups which are more or less distinct. Our domestic poultry in all its varieties has taken its origin from the Red Junglefowl, a pheasant

[1] Submitted for publication, January, 1943.

commonly reared in aviaries. Between the live pheasant and the live chicken there is a very apparent difference, but the dressed or cooked birds resemble each other rather closely.

In the preparation of this article, it was remembered that the ringneck rarely exceeds three pounds in weight, therefore poultry of the same size was used in this comparison. Various breeds of poultry were dissected in order to be certain that a definite distinguishing trait was characteristic of all domestic chickens and not of one individual bird or breed. In all, nine pheasants were studied, and twelve chickens, including barred rocks and heavy breeds, leghorns and bantams. Various ages of poultry were used in order to be sure that features did not change with age. Further, many other chicken bones collected from friends and restaurants were examined.

Minor distinctions between the pheasant and the chicken will not be stressed here due to the difficulty of the untrained eye in noting them, but there remain several readily discernible anatomical differences. It will be the purpose of this paper to explain these so that fish and game officers may efficiently pursue the outlaw pheasant hunter. Mere perusal of this article will, it is hoped, be helpful, but a more thorough background of knowledge will be obtained by those who use this text primarily as a guide to their own study of the features discussed.

To do this, a pheasant should be procured, and roasted or cooked in any manner which does not entail too much disjointing. After cooking, many of the joints will readily separate, and the flesh will usually be loosened fairly well from the skeleton. If the meat is eaten, be cautious not to break the wishbone, nor separate the bony leg tendons. When the bulk of the meat has been removed, boil the bones for an hour in a strong soap solution to remove grease and loose flesh. After this treatment the bones will be clean and nearly white, and will not develop any odor. On completion of the study, the wishbone, sternum (breast bone) and femur (upper leg bone) should be stored for future comparisons when questionable cases arise.

Differences Between Pheasant and Chicken

If it is at all possible to identify the bird in question without recourse to the skeleton, it is recommended that this be done. Examination of the bones involves handling the bird somewhat roughly, a procedure which might be embarrassing should it prove to be other than pheasant. Therefore those points which would assist in the determination by a superficial examination are given first. However, if these do not suffice, it will then become necessary to examine certain bones as the only infallible identifying features not altered or removed in the process of cleaning and cooking.

Size

As previously mentioned, a live, mature pheasant weighs between two and three pounds, rarely over. Except for the bantams, a mature chicken will weigh twice as much. A mature hen can be easily distinguished by its size, and a chicken young enough to be mistaken for a pheasant will have the breastbone incompletely ossified. A breastbone of this type is illustrated at the bottom of Figure 40.

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Appearance

There is a noticeable difference in the appearance of a dressed pheasant and a dressed chicken before cooking. The ring-neck is very full-breasted, the sternum being scarcely evident, whereas in the chicken this bone forms a noticeable ridge on the carcass. In the case of some of the very heavy breeds of bantams the carcass could resemble a pheasant.

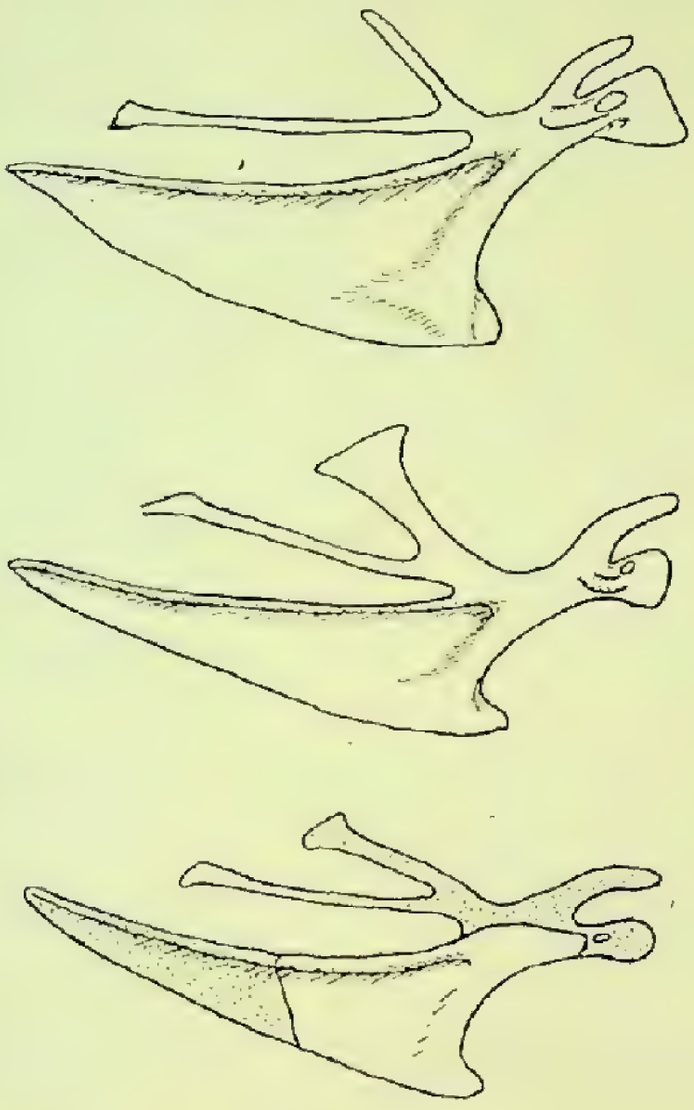

FIG. 40. Sterna (breast bones) of pheasant (top), mature chicken (center) and young chicken (bottom), showing incomplete ossification in young chicken. The differences in the lengths of the processes are somewhat exaggerated in these drawings

The meat of the uncooked pheasant is a clear pink in color; that of the chicken varies considerably, ranging to black in the case of the silkie. The fact that the meat is pink does not mean that the bird is a pheasant, but in case the carcass is of another color it suggests that the bird is probably not pheasant.

Shot

The presence of shot, and shot or bullet holes is a suggestion that the bird is probably not a domestic chicken.

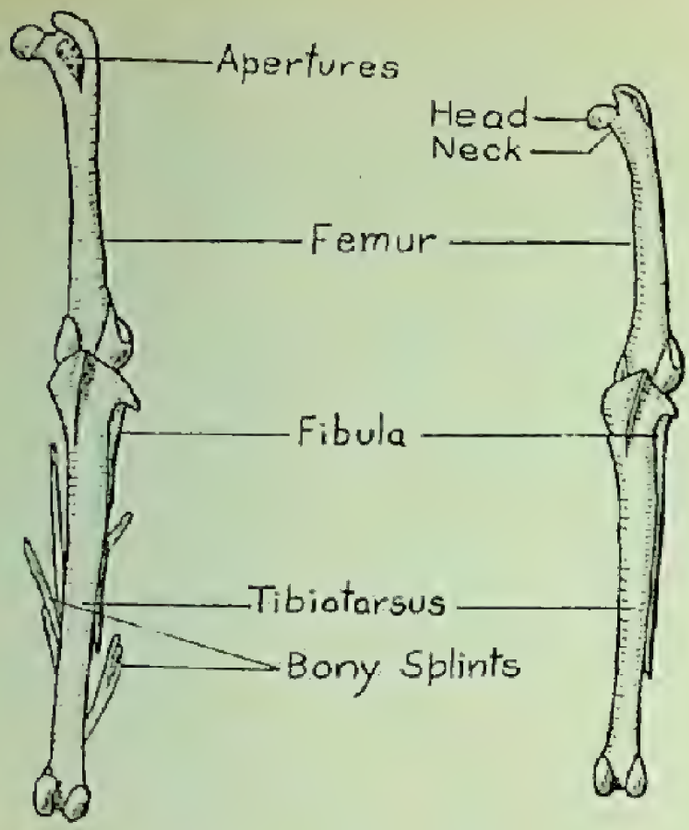

FIG. 41. Leg bones of pheasant (left) and chicken (right), showing identifying bony splints of pheasant.

41, and those visible on the surface of the leg are illustrated in Figure 42. Being easily found without damaging the bird, this very characteristic trait of the pheasant should be the first point sought for identification.

It has been suggested by some anatomists that this feature might possibly be found in very old chickens of some breeds. However, the red junglefowl, ancestor of all domestic poultry, does not possess this characteristic at any age, and the writer has failed to discover any semblance of this trait in chickens. Lacking evidence to the contrary, it seems logical to assume that this development does not occur in chickens.

Leg Splints

One easily visible identifying mark on the pheasant, either cooked or uncooked, is the presence of bony tendons or "splints" on the lower tibiotarsus, or drumstick. Anyone who has eaten turkey has noticed these flat, springy bones between the muscles of the drumstick. In the pheasant they are obviously not so large as in the turkey, but they are sufficiently large to be very evident. The usual appearance is that of small bony strips about half the size of toothpicks. Two and one-quarter inches is the maximum length of these splints, two of which can be seen and felt in the plucked bird. In life, they join the muscles to the bone and transmit muscular action. The splints are illustrated attached to the bone in Figure

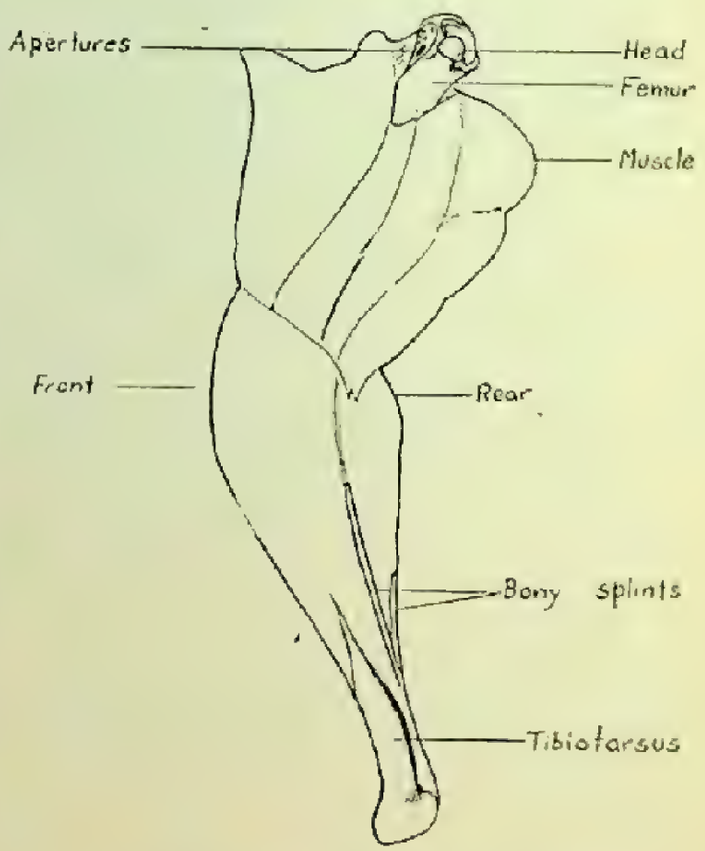

FIG. 42. Pheasant leg, inner side.

Wishbone

The wishbone is an excellent criterion for distinguishing between the two fowl in question. The wishbone is properly called the clavicle, and occupies the same portion of the bird's anatomy as does the clavicle or collarbone in man. It is found in the forepart of the breast, and can be easily removed with a sharp knife, but care must be used not to cut off the distinguishing features in the removal. In the illustrations (Figures 43 and 44) which compare the wishbones, the differences between the two birds are readily apparent. The most conspicuous difference is in the furcular process, the enlarged, flattened projection located at the union of the two branches of the wishbone. Note that in the pheasant this process is broadly triangular with the bony reinforcements forming a "V" on the edges of the thin middle area, as can be seen by holding the bone up to the light. Should the pheasant be uncooked, the "V" will appear red and opaque, whereas the remainder of the process will be pinkish and translucent. In the chicken the furcular process is irregularly oval in outline; is thicker and heavier throughout; and the reinforcements are not confined to the "V" on the edges.

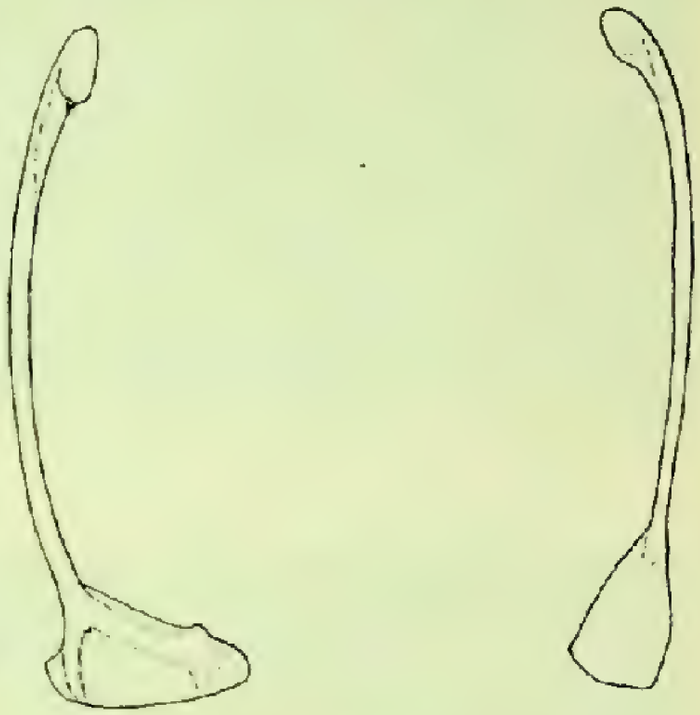

FIG. 43. Clavicles: pheasant (left) and chicken (right).

Femur

The femur or upper leg bone offers a point of difference which is readily found, but which is neither so conspicuous nor so conveniently located as some of the other features. In the upper end of the pheasant femur, on the fore side, there is a series of small apertures leading into the interior of the bone. (Fig. 42.) These apertures were found on every pheasant examined but there was not a trace of them on any chicken. An easy method of finding these openings into the bone is outlined. With a knife, cut the muscles of the leg up as high as possible where they meet the body. Pull the head of the femur out of its socket and remove the leg. Then by separating the meat from the bone slightly, these apertures will be readily visible on the front, inner edge of the femur. In addition, the head and neck of the femur are comparatively larger and heavier than those of the chicken.

Sternum

The sterna or breastbones illustrated in Figure 40 have several distinguishing features, but, being firmly attached to the rest of the bird, they unfortunately can not be removed without tearing the carcass apart. To the deep keel of the sternum is attached the massive flight muscles. It follows naturally that both the keel and the muscles should

FIG. 44a. Clavicles of chicken.

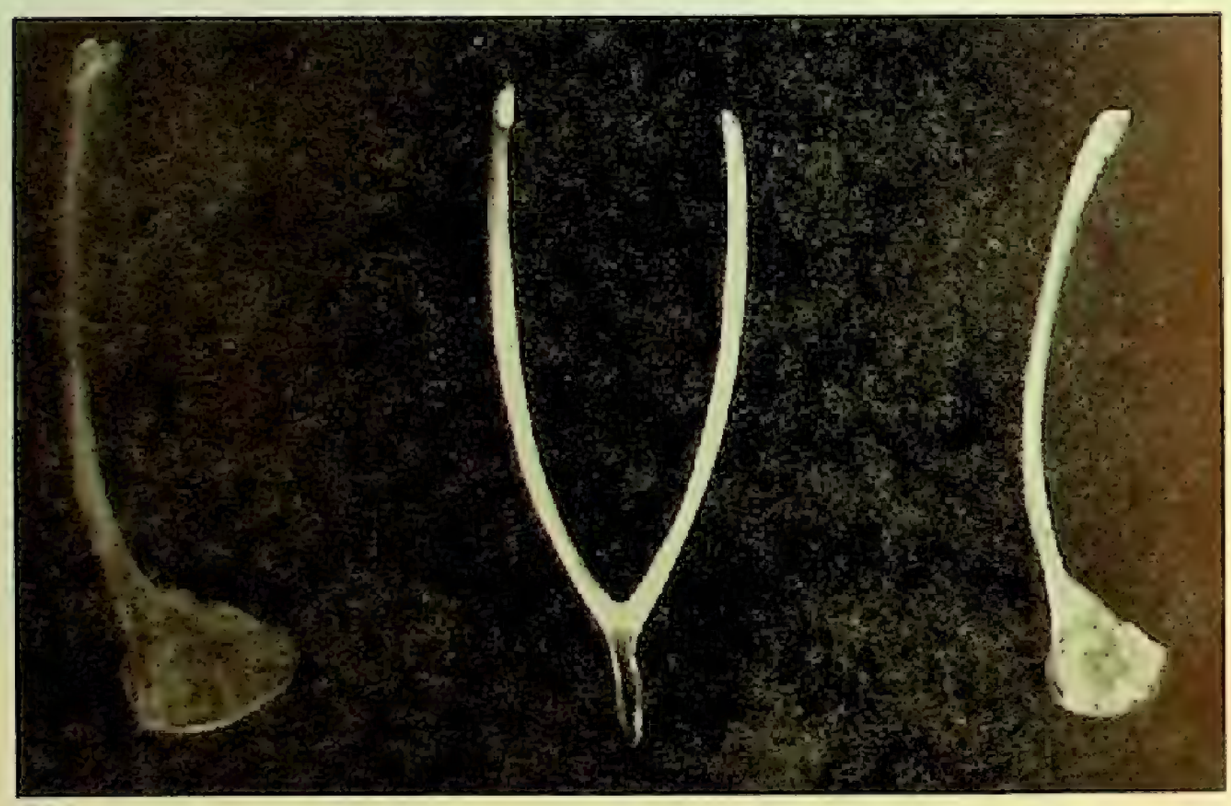

FIG. 44b. Clavicles of pheasant.

be reduced in a practically flightless bird such as the chicken. In poultry, the sternum is usually more shallow, and lacks certain features seen in that of the pheasant. It is readily noticed that the rib-like lateral processes of the chicken are broader, heavier and shorter. It would be difficult to describe these variations clearly, and the reader is referred to the figures illustrating them, or, better still, to a personal examination of the bones.

Summary and Conclusions

A study was made of nine pheasants and of twelve chickens of assorted breeds; also of many other chicken bones collected from friends and restaurants. The essential bones of all were saved for comparison with all others. There was found to be a great variation in the skeletons of the various types of chickens but a marked uniformity in those of the same breed. Likewise, the skeletons of the pheasants examined demonstrated great similarity.

The sternum, femur, and wishbone were found to be useful in determining the identity of an unknown fowl. Due to the great variation in the bones of the chicken, some of those used as identification points occasionally showed some similarity to the corresponding bone of the pheasant. However, even a casual examination brought out some very characteristic differences.

By far the best and most easily found criterion for determining the identity of the carcass was the presence of ossified tendons ("splints") in the drumstick of the pheasant.

This paper deals only with the domestic chicken and the common ringneck pheasant. It should not be used to distinguish the chicken from gallinaceous types other than this pheasant. Its text and illustrations will become more significant to the reader if he is able to supplement them with a study of specimens of the two types of birds, searching out for himself the differences herein described.

A PARASITE IN THE MUSCLES OF DUCKS IN CALIFORNIA[1]

By Carlton M. Herman and Gordon L. Bolander
Bureau of Game Conservation
California Division of Fish and Game

On December 13, 1942, a hunter shot an American pintail or sprig, *Dafila acuta tzitzihoa*, which contained lesions on the breast. The bird was taken at the south end of San Francisco Bay in Santa Clara County and was turned over to Warden C. E. Holladay, who transmitted it to the laboratory. Examination demonstrated that it was infected with *Sarcocystis rileyi*.

Sarcocystis rileyi is a protozoan parasite that lives between the muscle fibres of ducks. Similar parasites have been reported from other birds and from mammals, including a few rare cases in man. The means by which birds become infected is, as yet, unknown. The pintail examined was in fair flesh and there was no particular indication that it was suffering greatly from the infection. Other workers, however, stated that in severe cases the action of the flight muscles is impeded and the infection may be fatal. Figure 45 shows the breast of the pintail with the skin dissected away. Each white dash is a cyst containing numerous spores. A few such cysts occurred in the neck muscles, but the wings and legs were not involved. The heart muscles were not infected.

Fig. 45. Breast of pintail showing parasites.

In a recent review, Erickson (1940) listed six species of wild ducks as hosts to this parasite in North America. In this same paper he published the first report of the parasite in the pintail in a bird from Minnesota. Quortrup and Shillinger (1941) have added another species of duck and the coot. Wardens and other personnel of the California Division of Fish and Game have reported seeing this parasite in ducks in California, but to our knowledge the first published report was by Quortrup and Shillinger, who found it in a shoveller and in a green-winged teal from Tule Lake at the northern end of the state. They also reported it in pintails from Bear River, Utah, and Crescent

[1] Submitted for publication, March, 1943.

Lake, Nebraska. This, therefore, is the first report of an infected pintail west of the Rocky Mountains.

Quortrup and Shillinger, during a four-year period, autopsied a series of 3,000 birds of various species on western lake areas, mainly in Utah, California, Nebraska, North Dakota, and Montana. The majority of these birds were ducks suffering from botulism. Of all birds examined they found only 21, or 0.7 per cent, infected with *Sarcocystis*. All infected birds were ducks. This demonstrates a very low prevalence of the parasite in birds.

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1940. Sarcocystis in birds. Auk, vol. 57, pp. 514-519.

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1941. 3,000 wild bird autopsies in western lake areas. Jour. Amer. Vet. Med. Assoc., vol. 99, pp. 382-387.

EDITORIALS AND NOTES

RESIGNATION OF G. H. CLARK

Mr. G. H. Clark, who has held the position of Supervising Fisheries Researcher with the Bureau of Marine Fisheries of the California Division of Fish and Game since May 1, 1938, left the employ of the Division on February 1, 1943, to take a position with the Sea Pride Packing Corporation, where he will be directly concerned with the production of fish.

Mr. Clark first joined the staff of the Bureau of Marine Fisheries on June 15, 1926, and he has been with that Bureau since that time. During this period he has worked on a number of different subjects. His publications cover investigations of salmon, shad, striped bass and trawl-caught species.

Since the beginning of the Central Valleys Project, Mr. Clark has been in charge of the Bureau of Marine Fisheries' part of the work; and the success of the program is in large part due to his efforts.

Very few men are available who have had the experience in fisheries research possessed by Mr. Clark. His resignation represents a great loss to the Bureau of Marine Fisheries; and it will be very difficult to replace him.

The entire staff of the Division of Fish and Game wishes Mr. Clark every success in his new position.—*Richard Van Cleve, Chief, Bureau of Marine Fisheries, California Division of Fish and Game.*

YOUNG SPERM WHALE BEACHED AT MONTEREY

A dead sperm whale, *Physeter catodon*, was washed ashore on Asilomar Beach, near Monterey, California, on November 22, 1942. This specimen was a young female, 28 feet long, and had been dead for several days.

The sperm whale, which is also known as Cachalot, is one of the strangest of animals and can be recognized at once. It has an enormous head, the front of which ends bluntly as though squarely cut off. The lower jaw is slender and narrow and is studded with teeth. There are no functional teeth in the upper jaw. There is a single S-shaped blow hole on the left side of the snout. The flippers are small. A length of 75 feet is attained by this whale. It has been much sought-after by whalers because of the fine grade of oil found in the head.

During the last three years, the only whaling carried on in California waters has been by the San Francisco Sea Products Company, located at Field's Landing on Humboldt Bay. In 1940 a total of 29 whales was taken by this station. Nineteen of the whales were humpback, six were finback, and the remaining four were sperm whales. In 1941 a total of twenty-four whales was landed, of which sixteen were humpback, seven finback and the remaining one a sperm whale. No

figures are available for the 1942 season, but Fish and Game representative Paul Bonnot reports that but one sperm whale was landed during this past season.—*J. B. Phillips, Bureau of Marine Fisheries, California Division of Fish and Game, December, 1942.*

TWENTY-FIVE YEARS AGO IN CALIFORNIA FISH AND GAME

The July, 1918, issue of California Fish and Game was designated the "Kelp Number," in recognition of "a new and important industry." The importance of the industry derived from the use of kelp as a basis for the manufacture of potash, a necessary component of war ammunition which up to that time had been largely imported from South America. In 1918 in the neighborhood of 400,000 tons of the plant were harvested and burned for potash, but the Armistice in November of that year brought this activity to an abrupt halt. Throughout the 1920's practically no kelp was harvested. However, advances in the application of organic chemistry to industry developed new uses for the plant—in food, in cosmetic products, and in other lines—and slowly the harvest increased. In 1930 it was nearly 8,000 tons, in 1940 and 1941 over 55,000 tons annually.

The longest paper in that issue of the bulletin was "The Mackerel and the Mackerel-like Fishes of California," contributed by E. C. Starks in continuation of his series on the fishes of California. Although Professor Starks did not include quantitative data, it is of interest that in 1918 the commercial landings of the mackerel-like fishes (which include the skipjack and the tunas) totaled 35,000,000 pounds, while in 1940, the latest year for which published totals are available, landings were 260,000,000 pounds.—*Brian Curtis, Editor, California Fish and Game.*

MUSSEL POISONING TWENTY-FIVE YEARS AGO AND TODAY

In the July, 1918, issue of California Fish and Game, E. P. Rankin wrote an article on "The Mussels of the Pacific Coast" in which he discussed the question of mussel poisoning. He stated that the evidence indicated that most such cases came from mussels gathered high up on the rocks in hot weather, and that there was no danger in eating mussels taken from under the water on clean, open shores. These views were commonly held by scientists at that time, but work since then, mainly by Dr. Hermann Sommer and Dr. K. F. Meyer, has shown an entirely different source of mussel poisoning. In spite of this, and of the efforts made by the California State Department of Public Health to disseminate correct information, many people still cling to the erroneous idea that mussels taken on the open coast below low tide mark are always safe to eat. This is definitely not the case, since such mussels have at times been found to be more poisonous than those taken higher up.

The source of the poison is a microscopic marine organism called *Gonyaulax catanella* which at times occurs in sea water in enormous numbers. The mussel ingests this organism, along with the rest of the plankton elements which form its food, without suffering harm; but the human being who eats the mussel may die, if the numbers of

Gonyaulax in its digestive tract are sufficiently abundant. The chain then is a very simple one: the poisonous *Gonyaulax* goes into the mussel, which it does not harm, and then with the mussel into the human being, which it does harm. The mussel is merely a vehicle for the transportation of *Gonyaulax* from the sea water into the human. Pismo clams and Washington clams have at times been found to contain this organism, but molluses which live in lagoons and situations remote from the open sea are protected from contact with it. The abalone does not feed on plankton, and is therefore free from it.

There is no way of distinguishing poisonous from sound mussels by their appearance, or by their behaviour while cooking. Heat does not destroy the poison. *Gonyaulax* is much more abundant along the California coast in the summer months than at other times, all recorded poisoning cases having occurred between May 15th and October 15th. According to Drs. Sommer and Meyer, there is one simple, safe rule: "Do not eat the viscera (dark meat) of, nor drink the juice from mussels, clams or similar shellfish from the open Pacific Coast between the first of May and the first of November."—*Brian Curtis, Editor, California Fish and Game.*

REPORTS

FISH CASES

January, February, March, 1943

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalones: closed season, undersize, overlimit, out of shell, no license	18	$390 00	
Angling: no license, overlimit, closed season, closed area, 150 ft of dam, closed stream	30	565 00	
Bass: undersize, overlimit, using 2 rods, after sundown, night fishing	7	118 00	11
Bass, black: no license	1	10 00	
Catfish: selling undersize	1	30 00	
Clams: undersize, clam forks in preserve and taking clams in preserve, overlimit	23	457 50	
Clams, horseneck: overlimit	1	25 00	
Clams, Pismo: selling, no commercial license	1	25 00	
Cockles: overlimit	2	50 00	
Commercial: operating net and taking tuna in closed season, gill net in closed waters	6	800 00	
Frogs: closed season	1	50 00	
Gill net: closed area, meshes over 3¼" in length	1	100 00	
Lobster: closed season, undersize	2	110 00	
Salmon: taken illegally	1	25 00	
Steelhead: taken illegally, overlimit, no license	4	85 00	
Striped bass: for sale, no license, 2 rods	4	45 00	
Possession fish gaff within 300 ft of stream	5	105 00	
Operating fish trap	1	50 00	
Trout: other means than rod and line	1	25 00	
Possession 34 tagged steelhead District 1½	1	50 00	
Failure show license on demand	1	10 00	
Sunfish, crappie: no license	8	155 00	
Game fish: taken illegally	3	100 00	
Totals	123	$3,380 50	11

GAME CASES

January, February, March, 1943

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer: State Game Refuge, parts female deer, killing doe, taking buck fawn deer	15	$1,375 00	
Deer meat: closed season, unstamped, no permit	20	1,517 00	74
Firearms: game refuge	6	155 00	
Hunting: no license, at night	12	195 00	
Shorebirds	2	50 00	
Non-game birds	3	65 00	
Pigeons: closed season	1	25 00	
Pheasants: no license, closed season, closed area, hen	30	1,060 00	
Quail: no license, closed season	7	115 00	
Ducks: closed season, no license, overlimit, failure show game on demand	30	830 00	
Geese: closed season, overlimit, after sunset	7	170 00	
Waterfowl: closed season, before sunrise, after sunset, no license, overlimit	44	895 00	
Shooting from auto	1	50 00	
Failure show license on demand	9	80 00	
Rabbits—			
Brush: closed season	2		5
Cottontail: closed season	3	75 00	
Using license of another	1	10 00	
Mudhens: closed season, no license	1	35 00	
Migratory waterfowl: no duck stamp	2	50 00	
Making false statement to secure hunting license	1	100 00	
Possession spotlight and gun at night	5	250 00	
Kill and possess mountain sheep	2	200 00	
Shooting coots with 22 rifle	2	25 00	
Taking fully protected birds	1	25 00	
Shooting ducks from powerboat	17	750 00	
Set line (snare), wild hen pheasant and valley quail	1	300 00	
Taking tree squirrel	2	55 00	
Trespass	1	25 00	
Pollution	15	1,725 00	
Totals	243	$10,207 00	79

SEIZURES OF FISH AND GAME

January, February, March, 1943

Fish:	
Abalones, red	8
Abalones, green	109
Abalones, black	11
Bluegill, pounds	9
Catfish	7
Clams, Pismo	163
Clams, horseneck	35
Crappie, pounds	5
Frogs	10
Lobsters	7
Scallops	214
Steelhead	15
Sturgeon, pounds	42½
Sunfish, pounds	4
Trout	40
Tuna, bluefin, pounds	15,360
Game:	
Deer	7
Deer meat, pounds	504
Geese	19
Ducks	143
Pheasants	59
Pigeons	1
Quail	7
Rabbits, cottontail	3
Swans	11

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CENTRAL DISTRICT (Headquarters, Sacramento)

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Jos. H. Sanders, Captain ..... Sacramento
A. H. Willard, Captain ..... Rocklin
E. O. Wraith, Captain ..... Chico
L. E. Mercer, Warden, Butte County ..... Chico
Taylor London, Warden, Colusa County ..... Colusa
Albert Sears, Warden, El Dorado County ..... Placerville
E. C. Vail, Warden, Glenn County ..... Willows
Don Davison, Warden, Modoc County ..... Alturas
Earl Hiscox, Warden, Nevada County ..... Nevada City
Nelson Poole, Warden, Placer County ..... Auburn
E. J. Johnson, Warden, Plumas County ..... Quincy
Charles Sibeck, Warden, Sacramento County ..... Sacramento
Earl Caldwell, Warden, Shasta County ..... Burney
Chas. Love, Warden, Shasta County ..... Redding
Don Chipman, Warden, Siskiyou County ..... Dunsmuir
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A. Granstrom, Warden, Sutter County ..... Yuba City
R. W. Anderson, Warden, Tehama County ..... Red Bluff
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C. O. Fisher, Warden, Yolo County ..... Woodland
R. A. Tinnin, Warden, Yuba County ..... Marysville
Wm. LaMarr, Placer County ..... Tahoe City

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John O'Connell, Captain ..... Stockton
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L. R. Garrett, Warden, Calaveras County ..... Murphys
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Hilton Bergstrom, Warden, Merced County ..... Los Banos
H. Groves, Warden, Merced County ..... Merced
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Lee C. Shea, Captain ..... Napa
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W. J. Black, Warden, Humboldt County ..... Garberville
W. F. Kalliher, Warden, Humboldt County ..... Fortuna
M. F. Joy, Warden, Marin County ..... Tiburon
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Kenneth Hooker, Warden, Cruiser *Rainbow III*—San Rafael
Otis Wright, Assistant Warden—Monterey
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Robert Mills—Santa Barbara
N. C. Kunkel, Warden—Terminal Island
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T. W. Schilling, Warden—Terminal Island
G. R. Smalley, Warden—Richmond
T. J. Smith, Warden—San Diego
L. G. Van Vorhis, Warden—Terminal Island
E. L. Walker, Warden—Terminal Island
Carmi Savage, Warden—Terminal Island

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H. L. Lantis, Warden—Long Beach
R. L. Schoen, Warden—Wilmington
Walter R. Krukow, Assistant Warden—Santa Barbara

MARINE PATROL AND RESEARCH BOATS

Cruiser *Bonito*, Newport Harbor
Cruiser *Rainbow III*, San Rafael
Launch *Shrapnel*, Suisun

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